2019

ANALYZING THE CORRELATIONS AMONG DRIVER DISTRACTIONS AND THE PROBABILITY OF AN ACCIDENT

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BY

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

INDUSTRIAL AND SYSTEMS ENGINEERING

UNIVERSITY OF RHODE ISLAND

2019

MASTER OF SCIENCE

OF

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2019

Abstract

The use of the car is an integral part of the everyday life of many people. As most people spend more time in the car, the number of accidents has also risen in recent years. Globally, traffic accidents are the most common cause of death. Although vehicles are becoming safer and safer, many accidents are caused by driver carelessness or distraction. However, supposed secondary activities in everyday driving behavior can have fatal consequences. Driving while using the phone is one of the few secondary occupations that is prosecuted in Germany and the USA. This master's thesis examines risk factors that distract the driver while driving. The participants are questioned in a survey to make general statements about driving behavior. In a driving simulation experiment, the effects of the distracting behavior while driving are investigated. In detail, the influence of the main factors Hand-on-Wheel, Background-Noise, Weather and the interaction of these main factors on driving performance will be investigated. Ultimately, the experiment proved that even seemingly insignificant secondary occupations influence the driver's driving performance. Even if some main factors did not affect driving performance alone, all the factors analyzed in combination with another main factor compromise driving performance.

Acknowledgement

First of all, I want to thank my committee members, specifically my advisor Professor Jyh-Hone Wang for their personal support, helpful suggestions and constructive criticism during the preparation of this Master's thesis.

Furthermore, I want to thank Sanaz Motamedi for her help and guidance with my study.

Also, I have to thank my friend and lab neighbor Alaa Masrahi for his constant helpfulness, our fruitful discussions, his motivation and the pleasant working atmosphere around the clock.

Then, I want to thank my new American friends and fellow German students who came with me to Rhode Island, who all supported me with a lot of patience, interest and helpfulness during my thesis and with whom I had a great time studying.

And finally, I would like to express my heartiest thanks and gratitude to my family and particularly my parents. They made my study possible and always supported me morally and motivated me.

The Tasks of this Master work

Increasing mobilization has led to more and more people owning a car. The International Transport Forum of the OECD predicted that the number of cars worldwide will reach 2.5 billion by 2050. According to statista.com, 79 million new vehicles will be sold by the end of 2019. Driving has become a daily routine for many people. According to the U.S. Census Bureau, the average driving time to work in the USA is 26.1 minutes. At five working days a week, the average commuter spends 4.35 hours a week and over 200 hours a year in the car. Along with the increasing use of the car, the number of accidents has also increased in recent years. In a report published by the World Health Organization, more than 1.35 million people died in road accidents worldwide in 2018. Furthermore, 50 million people were injured in traffic accidents. On average, 18 people per 100,000 inhabitants die each year in road traffic accidents worldwide. Based on data from the National Highway Traffic Safety Administration, an average of 12.4 people per 100,000 inhabitants died in 2016 as a result of accidents in the USA. Of these fatalities, 34% were caused by drivers or occupants of vehicles with 4 or more tires. The World Health Organization has compiled a list of the greatest risks in road traffic. These include speeding, driving under the influence of alcohol and other psychoactive substances, non-use of motorcycle helmets, seat belts, child restraint systems, unsafe road infrastructure, unsafe vehicles, inadequate post-accident care, deficient enforcement of traffic rules and distracted driving. Although vehicles are becoming safer, more and more accidents are caused by driver carelessness or distraction.

ln 2010, 3,267 people died in accidents on U.S. highways. The National Highway Traffic Safety Administration later attributed the cause of the accidents to driver distraction. ln the same year, the total number of crash-related fatalities (32,367) reached its lowest level since 1949. The total number of accidents diminished by 1.9% in the

following year. In contrast, the number of crash-related fatalities caused by driver distraction rose by approximately 1.9% to 3,331. This means that approximately 10% of all crash-related fatalities were caused by driver distraction. This thesis focuses on the factor of distracted driving. The main causes of distraction while driving are telephone conversations, reading SMS messages, applying personal cosmetics, searching for a place in the navigation menu or distracting passengers. The distraction by the smartphone is a well-known phenomenon and has been addressed in various studies and publications. Therefore, the focus of this work is deliberately not on the smartphone. The purpose of this master's thesis is to research the influence of one handed driving, background noise and the weather on the driving performance. The factors are deliberately chosen to correspond to a vehicle on a conceivable routine drive. It will be possible to make a statement with the results as to how likely driving errors are with these behaviors. After the identification of the test factors, a test plan using design of experiments was designed.

This assignment comprises of the following tasks:

- Conduct a comprehensive literature review on the significance of distracted driving in road traffic and its impact on accident statistics to obtain overview of the current state of research on distracted driving.
- Design an experiment based on the results of the literature research. Within this framework, the main and blocking factors will be determined and the experimental design with the design of experiment will be created. Later on, a test environment

on the driving simulator will be designed for the experiment and a survey will be created to determine the general driving behavior of each test group.

- Conduct the survey and the driving simulator experiment with participants who will make analysis possible.
- Evaluate the initial variables of the survey and the driving Simulator and evaluate them with a statistical model. The results will be written in a form of a thesis.
- Critical review of the developed approach and gained results
- Oral presentation of the results

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1 Introduction

The daily use of the car is an integral part of the everyday life of many people. Since the invention of the first automobile, the number of cars worldwide has increased every year. In 2015, worldwide around 947 million passenger cars and 335 million commercial vehicles were in operation [1]. The International Transport Forum of the Organization for Economic Co-operation and Development (OECD) predicted that the number of cars worldwide will reach 2.5 billion by 2050 [2] [3].

The car is indispensable as a means of transport for most people, especially in regions with little or no local transport. Every American spends an average of more than 290 hours a year on the road, covering an average distance of 10,900 miles (17,541.84 kilometers) a year [4]. And by the end of 2019, around 79 million new automobiles are expected to be sold [5]. In line with the increasing number of cars, the number of accidents has also risen steadily in recent years. According to a report by the World Health Organization, more than 1.35 million people died in road accidents worldwide in 2018. In addition, another 50 million people were injured in road accidents in the same year. On average, 18 people per 100,000 inhabitants die each year in road traffic accidents worldwide. Globally, road accidents are the most common cause of death among children and young people between the ages of five and 29. Traffic accidents were the eighth most common cause of death among all age groups in 2016. More people die as a result of an accident than from tuberculosis or HIV [6].

The officially reported number of road deaths in the USA was 35,092 in 2016. Two years earlier, the number of road deaths was 32,744. This is 2,348 more than in 2014, and the number of road deaths per 100,000 inhabitants in the USA was 12.4 per year in 2016 [7]. Of these fatalities in 2016, around 34% were attributable to drivers or occupants of vehicles with four or more tires. Twenty-three percent are drivers or passengers of two to three wheeled vehicles. Three percent are bicycles and 22% pedestrians. Eighteen percent of accident fatalities cannot be assigned to a single category. The World Health Organization has compiled a list of the greatest risks in road traffic. These include speeding, driving under the influence of alcohol and other psychoactive substances, non-use of motorcycle helmets, safety belts, child restraint systems, unsafe road infrastructure, unsafe vehicles, inadequate care after an accident, inadequate enforcement of traffic rules and distracted driving [8]. Although vehicles are becoming safer, accidents are caused by driver carelessness or distraction.

In 2016, accidents attributed to driver distraction were 3,450, a decrease of 2.2% from the previous year. In 2015, the number of accident fatalities was 3,526. Nevertheless, 263 young people (aged 15 to 19) were killed by distracted driving in 2016. This corresponds to 10% of all fatalities in young motor vehicle accidents in 2016 [9]. The main causes of distraction while driving are telephone conversations, reading text messages, putting on personal cosmetics, searching for a place in the navigation menu or distraction caused by passengers [10].

The influencing factors that lead to distracted driving in Germany and the US will be evaluated in this thesis. According to the U.S. Census Bureau, the average driving time to work in the USA is 26.1 minutes. At 5 working days a week, the average commuter spends 4.35 hours a week and over 200 hours a year in the car [11]. For many people, daily driving has become routine. Especially, people for whom driving has become routine pay less attention to the actual process of driving. This is typical for frequent commuters.

In a study conducted by Allianzen Versicherung, a German insurance company, in 2011, 40% of respondents stated that they often use their mobile phones while driving. Far more than half eat or drink regularly while driving. More than 40% also adjust seat belts, seats and mirrors while driving. One third read or write text messages or e-mails while driving [10]. The smartphone has become an immense source of distraction, especially among young people. The desire to be constantly reachable and the fear of missing something has led many drivers to look at their smartphones while driving. This has led to many accidents in recent years. According to the U.S. National Safety Council, the use of mobile phones while driving encompasses 1.6 million accidents per year [9].

The distraction by the smartphone is a well-known distraction and has been addressed in various studies and publications. Therefore, the focus of this work is deliberately not on the smartphone. In the course of this thesis, the influence of one-handed driving, background noises and weather conditions on driving performance will be investigated. The main factors are deliberately chosen to simulate the environment that prevails in many vehicles, especially in the morning. Listening to music from the radio is part of the normal soundscape of many drivers. In addition, some drivers consume a coffee or other beverages on their way to work. The danger of these everyday distractions, which have become a daily routine for many drivers and are no longer even perceived, is examined in more detail in this thesis.

2 Background

The vehicle population in both Germany and the USA has risen steadily since its introduction. This chapter explains the importance of the car and its current use in Germany and the USA. It also accounts for the different types of distractions and how they occur in road traffic. Based on the distractions, their influence on driving performance and the resulting accident risk is explained.

2.1 Cars and traffic in the United States and Germany

As the world population continues to grow, so does the number of road vehicles. Thus the volume of traffic on the roads rises. In almost all Western countries, the number of vehicles has risen continuously since the Second World War. The number of private cars has quintupled worldwide since 1960 [12] [13]. The USA and Germany were pioneers in motorway construction and promoted motorization at an early stage. Both countries have much in economic, political and cultural aspects in common. The economic upswing has led to a rising standard of living and growing per capita income in both countries. This has encouraged mobility, motorization and car use. The rapid expansion of the road network in both Germany and the USA since the Second World War has always made car use attractive and comfortable. In contrast to most other Western European countries, Germany has attempted to straighten the structure of the cities after the destruction caused by the Second World War and to orient them more towards car traffic. Urban planners often followed the example of American cities and the general growth of car traffic [12] [13].

Culturally, the car is a symbol of socioeconomic status, individual freedom and lifestyle in Germany and the USA [12]. Personal mobility in both countries is essentially based on the car. In the USA, there is a stronger one-sided dependence on the car, because many regions are sparsely or not at all connected to the local public transport network. Although Germany had similar growth in car ownership and use as the USA, it was more successful in limiting car traffic [13]. This is partly due to the preservation of local public transport. For this reason, the following side effects of transport such as environmental damage, loss of landscape, health problems due to poor mobility, deaths and injuries due to traffic accidents, loss of productive time due to traffic jams, dependence on oil imports and the impairment of opportunities and accessibility for non-motorized population groups are not quite as pronounced in Germany as in the USA [12] [13] [14].

In the following section, the degree of mobilization of society in Germany and the USA will be examined in more detail.

2.1.1 Degree of motorization in Germany and the USA

Motorization in the USA and Germany has risen almost continuously over the past decades. In 1939, there were 22 cars per 1,000 inhabitants. However, the Second World War reduced the number again, which is why in 1950 there were only 12 cars per 1,000 inhabitants [15] [16] [17]. Shortly before German reunification, the number of cars in West Germany had risen to 482 per 1,000 inhabitants. At that time West Germany was the country with the second highest motorization in the world, after the USA [18]. In East Germany, the degree of motorization was much lower. In 1988, there were 224 cars per 1,000 inhabitants. After the reunification of the two German states in 1990, the degree of motorization in united Germany increased by one fifth from 458 to 550 cars per 1,000 inhabitants by 2005 [19].

In the USA, the motorization of broad sections of the population began in the 1920s and 1930s, earlier than in any other country. By 1939, there were over 200 cars per 1,000 inhabitants, ten times higher than in Germany [20]. Figure 1 shows the development of motorization from 1960 to 1990 in Germany and the USA.

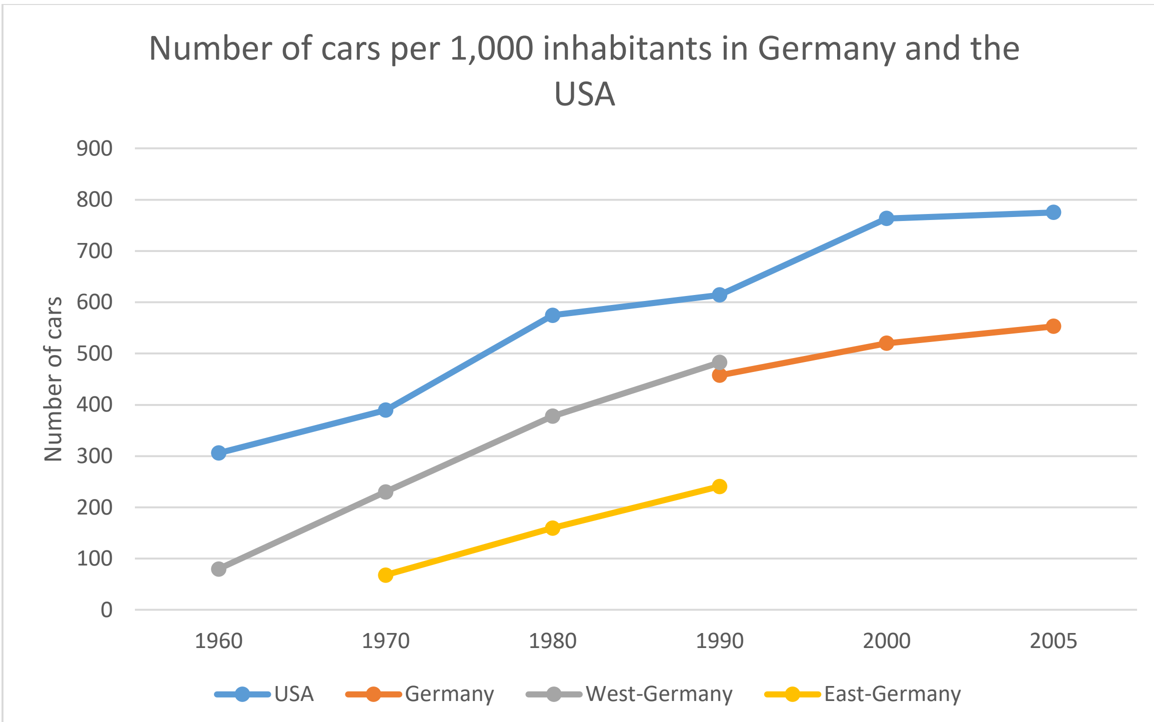

Figure 1: Development of vehicle ownership in the USA and Germany [after [21]*]*

Over time there has been a clear change in circumstances. In 1960, Americans owned four times as many cars as people in West Germany. In 1990, the gap in the degree of motorization had fallen to below 30%. Since 2000, however, a contrary trend can be observed again. By contrast, households with several cars occur twice as frequently in the USA (60%) as opposed to in Germany (27%) [22] [23] [24].

At this average level of motorization, there are differences between rural regions and cities in both countries. Among households in the USA outside the Metropolitan Statistical Areas (MSAs), the proportion of car-free households fell from 12% in 1977 to 6% in 2001. In larger MSAs with more than three million inhabitants, this proportion fell from 26% in 1977 to 12% in 2001 [25].

In Germany, 32% of households in large cities did not have a car in 2004. In rural areas, only 17% of the households did not have a car in 2004 [23] [24]. In Berlin, for example, the number of car-free households is significantly higher. In 2006, there were only 365 vehicles per 1,000 inhabitants [26].

Although the gap in motorization between the two countries has narrowed over the decades (see Figure 1), the current level of motorization of German households with vehicles corresponds to that in the USA 30 years ago. This underlines the much earlier and stronger spread of car ownership in the US.

The next section describes the different use of cars in the two countries.

2.1.2 Use of cars in the USA and Germany

A study conducted in the USA in 1976 found that each car owner made an average of 2.9 trips per day. A new survey in 2001 showed an increase of 40% to 4.1 trips per day. In almost the same period, the number of trips per person in Germany increased by only 6%. In 1976, every driver in West Germany made 3.1 trips a day. In 2002 this figure had risen to 3.3 journeys [22] [23] [24]. In comparison, people in the USA made an average of about one-fifth more trips by car per day than people in western Germany or Germany (4.1 to 3.3 trips). Thus, Americans made on average about one fifth more trips by car per day than people in West Germany or Germany (4.1 to 3.3 trips).

From 1969 to 2001, the average daily distance traveled in the USA increased by 90% per person. In 1976, every person in the USA covered 19.26 miles (31 kilometer) per day. By 2001, this figure had risen to 36.66 miles (59 kilometer). In contrast, in Germany the daily distance per person was 16.78 miles (27 kilometer) in 1976. In 2002, this distance had increased by 37% to 23 miles (37 kilometer) [22] [23] [24]. Therefore, Americans covered about 60% longer daily distances in 2001/2002 than German drivers.

From 1976/1977 to 2001/2002, the average distance traveled per route increased by only two kilometers. In 2001/2002 it was 9.94 miles (16 kilometer) in the USA and 6.84 miles (11 kilometer) in Germany. This means that the total distance traveled in the USA today is 44% longer than in Germany [22] [23] [24].

Even before 1977, more than 80% of all journeys in the USA were made by car. In 2004 this share had risen to 86%. The remaining journeys in the USA are made on foot (8.6%), by public transport (1.6%) or by bicycle (0.9%) [25] [27]. The trend in car use in Germany is similar to that in the USA. In 1976, an average of 45% of all journeys in Germany was made by car. In 2001, 61% of all journeys were made by car (see Figure 2 and Figure 3).

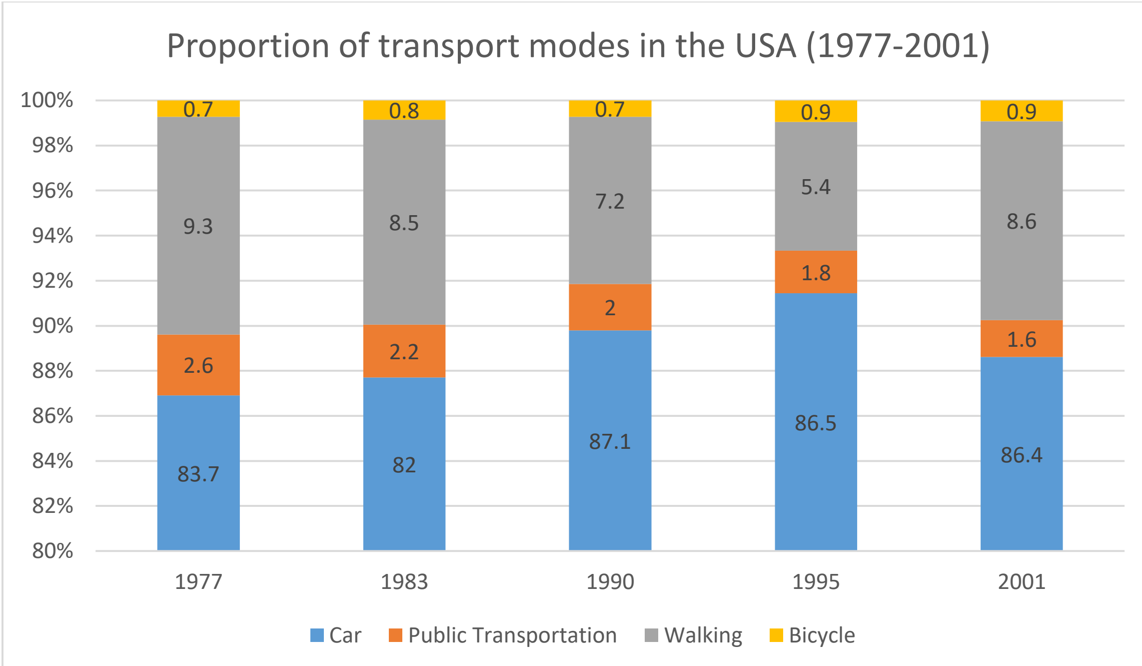

Figure 2 Transportation in the USA [after [21]]

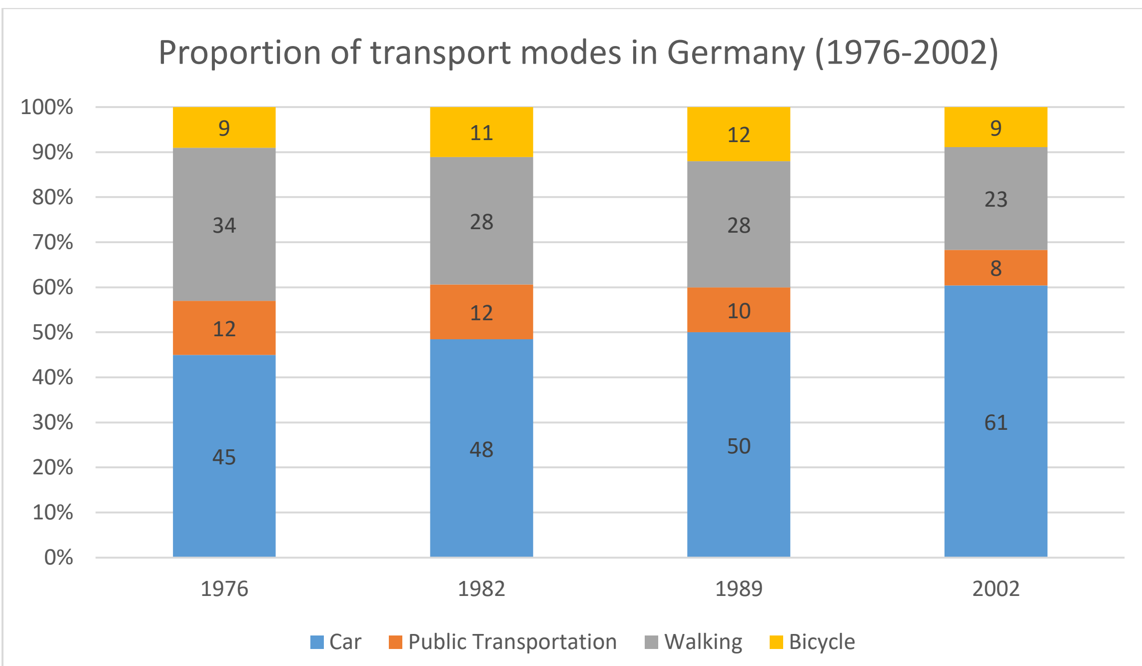

Figure 3 Transportation in Germany [after [21]*]*

In contrast to the USA, however, other modes of transport continue to be used to a large extent in Germany. Of the remaining 40%, an average of 23% of journeys are made on foot, 9% by bicycle and 8% by public transport (see Figure 2). The national trends and shares in the choice of transport naturally hide differences between regions and cities [24]. Although the use of the car has increased in Germany, the figures show that the car is still used for a smaller proportion of journeys than was the case in the USA 30 years ago (see Figure 3). The following section describes the trends in car use in Germany and the USA.

2.1.3 Traffic in Germany and the USA

Since 1970, per capita car journeys in the USA and Germany have risen by over 50%. In 2007, each German covered about 6835.08 miles (11,000 kilometer) by car per year. In the USA, it was 14,912.91 miles (24,000 kilometer). As described in section 2.1.1, car use has increased sharply in the USA and Germany. While the trend in the USA continues unabated, the trend in Germany has flattened out over the past 10 years. From 1995 to 2007, the annual distance traveled per person rose by 6% in Germany and by more than 13% in the USA. In the same period, the number of trips by public transport in Germany rose from 120 to over 135 per capita [21]. In the USA, on the other hand, demand for public transport has declined. Each US citizen made on average only 32 journeys in 2002. In 1970, there were still 36 journeys per inhabitant. On average, local transport in Germany is used four times more frequently than in the USA [21].

The stronger demand for public transport in Germany means, among other things, that the share of commuter traffic in major German cities is only 60% on average. Among the US metropolises, New York is the city with the lowest share of 66% commuter traffic in normal daily traffic. In all other US metropolises, commuter traffic has a share of over 80%, in most cases even over 90% [28].

Traffic congestion is a permanent condition in large and growing metropolises around the world, such as Los Angeles, Tokyo, Cairo, and São Paulo. At peak times between 6 a.m. - 9 a.m. and 3 p.m. - 6 p.m. traffic comes to a virtual standstill in many cities. Based on the traffic data of all American cities in the report of the data provider INRIX, the USA ranks as the most heavily trafficked industrial nation in the world, with an upward trend. American drivers spend an average of 41 hours a year in traffic jams during peak periods. The front-runners in these periods are the drivers in Boston (MA). Here, drivers spent 164 hours in traffic jams in 2018 during peak periods. In the previous year, it was only 60 hours. In Los Angeles (CA), this figure rose from 102 in 2017 to 128 hours a year later. In New York City (NY), the number rose by 42 hours to 133 hours in the same period [29] [30].

The American traffic data provider INRIX concluded in a study that in 2018 every driver in Berlin spent an average of 154 hours in dense traffic and traffic jams. The Bavarian state capital ranks second in the INRIX ranking with 140 hours. Hamburg commuters came in third with 139 hours. Behind them are the cities of Leipzig and Stuttgart with 108 hours each [29] [30] [31].

There are increasing trends in both countries in car use and time in a car as well as the number of hours spent in traffic. The increasing time spent in a car also increases the probability of an accident. Also, the probability of distracting oneself by secondary occupations increases due to the time in the car.

In the following section, the distractions while driving will be discussed in more detail.

2.2 Inattention and distraction in traffic

Secondary activities in a car fundamentally affect the attention and responsiveness of drivers. Even if the distraction lasts a few seconds, the distraction provokes driving errors. In several tests, the German ADAC Unfallforschung (ADAC Accident Research, equivalent to the US organization “AAA”) has identified short inattentions of drivers due to a secondary activity while driving as the cause of an accident. Many experts regard the "distraction" factor to be just as dangerous as drunken driving [32].

Driving a car is a complex task that requires mental, physical, visual and acoustic skills from the driver, whether the car is on a busy road, in a city or on an abandoned country road. Concentrating on things other than the driving task increases the driver's risk of being involved in an accident. In 2012, the AAA Foundation for Traffic Safety conducted a road safety survey. The survey concluded that the majority of respondents see a great danger in "distracted driving". Of the participants 88.5% of the respondents considered making a phone call while driving to be a major risk. Nearly 95% of respondents felt that writing a text or checking email was also a serious security risk. Also, visiting social media accounts while driving is considered extremely risky by respondents [33].

However, many of the distractions to which drivers are exposed are not perceived by the driver as real distractions. According to the National Highway Traffic Safety Administration (NHTSA), the driver is considered to have disregarded the vehicle and is therefore at risk as soon as he performs an activity that requires his attention in addition to the main task of driving. The danger in the distractions generally lies in the fact that the analysis of the road for possible dangers does not take place. According to the AAA Foundation for Traffic Safety, typing the destination into the navigation system is one of the greatest safety risks when driving. On average, the driver is occupied with programming for about 40 seconds [34]. Most drivers underestimate the danger that can emanate from a few inattentive seconds. At a speed of 30 miles/hour (48.28 km/h), the vehicle travels 44 feet (13.41 meters) per second.

$$\frac{30\,miles}{1\,hour} x \frac{5280\,feet}{1\,mile} x \frac{1\,hour}{3600\,seconds} = 44 \frac{feet}{second} \tag{1}$$

At a speed of 30 mph, the vehicle covers a distance of 1,760 feet (536.45m) in the 40 seconds required by the driver to adjust the navigation system. During this time, the driver does not look at the road, or only looks at the road occasionally, and will thus fail to recognize a possible change on the road later. The danger is that the less attentive the driver is to the road, then the less time the driver has to react to such a sudden change.

The Governors Highway Safety Association has divided the causes of driving distractions into four categories: visual, acoustic, manual and cognitive [35]. In the following sections, the four categories are explained in more detail.

2.2.1 Visual distraction

Visual distractions while driving are distractions that draw the driver's attention to themselves. The distraction can take place inside or outside the vehicle. An example of distractions outside the vehicle are advertising signs on the roadside. The U.S. Department of Transportation and University Transportation Centers Program commissioned a study on distracted driving in 2013 [36]. The study looked at the effects of roadside distractions on driving performance. It concluded that roadside events have significant effects on lane position variability and speed fluctuations. The more noticeable and larger the roadside distractions are, the greater the influence on the driver's carelessness. This inattentiveness was shown by higher error rates in the experiment. The study explicitly identifies particularly conspicuous distractions such as work zones and certain advertising signs which are thus a risk to road safety [36].

In another experiment, researchers Kircher and Ahlstrom used a driving simulator to investigate the influence of tunnel design and lighting on driving performance [37]. They concluded that as soon as the tunnel design and the lighting influence the visual attention of the driver, for example through color, the driver's performance decreases. However, the results also showed that bright tunnel walls can be used to direct the driver's visual attention forwards and thus increase safety in the tunnel [37].

2.2.2 Acoustic distraction

Acoustic distractions include activities that tempt the driver to concentrate on hearing or directing his gaze in a particular direction. Examples are conversations in a car or listening to music on the radio.

Researchers from the Department of Psychology at the University of Guelph, Canada, investigated the influence of playing audiobooks on driving performance [38]. They let the test persons drive in a driving simulator while the audiobook was running in the background and again in silence. While driving, the test persons were confronted with various situations, such as pedestrians or vehicles, which suddenly crossed the path of the vehicle. To measure driving performance, the researchers measured the braking reaction time to hazards. Surprisingly, the researchers came to the conclusion that playing an audiobook in a normal environment improves driving performance. However, as the environment became more complex, for example, due to bends, traffic or pedestrians, the audiobook contributed significantly to the driver's mental workload. In these environments, the addition of the secondary task led to a reduction in driving performance [38].

An important source of distraction in traffic is also telephoning while driving. The distraction of telephoning is not only attributed to the operation and holding of the device, but also, the division of attention between driving and talking is a distraction. For this reason, a hands-free system does not make it safer to make a call while driving than to make a call with a mobile phone in your hand.

Several studies have shown that hands-free and handheld telephony lead to the same high distraction of the driver. The researchers Desmet and Diependaele of the Knowledge Center Road Safety in Belgium have conducted a study on the effects of hands-free talking on eye movement patterns while driving in traffic [39]. For the experiment, thirty participants made two consecutive journeys of about 8.7 miles (14 kilometer) on a three-lane motorway. During the first or second trip, each participant received a call on a hands-free device in the vehicle. The analysis of the eye movement pattern showed that other vehicles, traffic signs, or the speedometer were less fixed by the driver. The driver's visual scan pattern, on the other hand, showed a broader spatial distribution of eye fixations during a hands-free call. Based on these findings, the researchers concluded that the driver's eye behavior when making a phone call via a hands-free system is less strongly determined by the driving task. This means that the driver concentrates less on traffic-related information during the call and is more susceptible to not perceiving changes on the road directly, thus having a higher accident risk [39].

2.2.3 Manual distraction

Manual distractions include activities that require the driver to operate the vehicle in a compromise way that inhabits control. Activities such as adjusting the side mirror on a car, changing the radio station or typing the destination into the navigation system usually require the driver to take at least one hand off of the steering wheel. In the event of a change on the road, the driver may need to take both hands back to the steering wheel before reacting. In addition, manual distractions rarely occur alone when driving, but most distracting activities involve both a manual and another type of the four categories of distraction. An example of this is writing text messages manually while driving. For the driver, writing usually means a visual distraction in addition to manual distraction by the driver looking at the text field. The rapid spread of smartphones and social media has made the use of mobile phones one of the most significant manual distraction factors in road traffic in recent years. The constant use of the smartphone is part of the everyday life of many people.

The effect of writing text messages on the mobile phone while driving has been discussed in more detail by Motamedi and Wang (2016) in their paper "The impact of text driving on driving safety" [40]. For their experiment, they interviewed participants with a questionnaire about their behavior regarding typing while driving. They concluded that the majority of the participants are aware of the safety risks of typing. Nevertheless, more than a quarter of them reported frequently sending or reading text messages while driving. Following the questionnaire, the researchers measured the respondents' driving performance in a driving simulator, while they were engaged in some forms of texting while driving and under different traffic conditions. As a result of the experiment, it was demonstrated that hands-free texting with a dictation function achieves much better driving performance in various challenging situations than manual texting with a mobile phone. The authors also point out that the results of the study support the idea that reducing visual and manual distractions improves driving safety [40].

In another attempt to access distractions, a study on smartphones in road traffic has been carried out at the Highway Safety Research Center of the University of North Carolina. The researchers in North Carolina investigated the "Effects of mobile phone distraction on pedestrians' crossing behavior and visual attention allocation at a signalized intersection" [41]. In an experiment, the researchers observed the behavior of pedestrians crossing a road. While crossing the street, the participants listened to music, made mobile phone calls or wrote a text message on their mobile phones. The researchers concluded that manual writing with a mobile phone as a secondary activity is the most demanding of our attention. Pedestrians who were distracted by writing texts on their mobile phones looked around much less often when crossing the street. Also, they generally paid much less visual attention to their surroundings. Thus these pedestrians, who are distracted by this manual secondary activity, pose an immense risk to themselves and other road users through their inattentiveness [41].

2.2.4 Cognitive distraction

Cognitive distractions while driving include activities that distract the driver's mental attention from driving. They usually occur together with visual, manual or acoustic distractions, because these distractions cannot be mastered without the driver concentrating on the secondary activity.

Motamedi and Wang compared in their publication also the influence of Hand-Held and Hands-Free Cell Phone writing with the mobile phone [40]. In addition to writing a text message, they also tested the driver's response to reading a text message. They distinguished between those text messages that required an answer and those that should only be read. The evaluation clearly shows that the drivers who had read a text to which they did not have to respond with an answer showed significantly better performance when driving. It is likely that after reading the text, the driver will be able to focus his attention on the driving again, while the driver who is expected to answer is still mentally occupied with the answer [40].

Researchers from Tsinghua University (China), University of Leeds (UK) and Beihang University (China) also conducted an experiment to investigate the influence of cognitive distraction on driving [42]. The experiment aimed to understand how driving performance, measured here in terms of lane keeping power, changes during the simultaneous performance of a demanding purely cognitive task. The experiment was divided into three difficulty levels. While the participants drove in a driving simulator on a four-lane city street with a bicycle path and a sidewalk, they were told numbers. Depending on the level of difficulty, the numbers were asked to be recalled immediately, after some delay, or in a different order. The study comes to the conclusion that as the difficulty level of the task increases and the cognitive load increases, the lane keeping performance decreases noticeably. An increasing cognitive load has a negative effect on driving performance [42]. For a real driving environment, this means an increase in the probability of an accident. In the previous sections, the distractions were considered individually.

The next section looks more closely at the effects when different categories of distractions, such as visual, acoustic, manual and cognitive occur together.

2.2.5 Combination of different distraction

Divided attention is the ability of the human brain to perceive several different stimuli simultaneously. By dividing the attention, it is possible to process different sources of information and to successfully perform several tasks at the same time. This cognitive ability is important because it enables us to meet the demands of the environment, which almost always consists of more than one stimulus [43]. Cognitive processing is generally defined as "The mental action or process of acquiring knowledge and understanding through thought, experience, and the senses" [44]. However, the term cognitive is not used uniformly and describes a multitude of intellectual functions and processes. These functions and processes include information processing, knowledge formation, working memory, problem solving and decision making. Cognitive processes use existing knowledge and generate new knowledge.

The ability to share attention can be impaired by disease. Examples are schizophrenia or diseases such as attention deficit with hyperactivity disorder (ADHD). A craniocerebral trauma or a stroke can also lead to an attention deficit disorder. If the ability of divided attention is reduced, any distraction can affect the tasks performed simultaneously. For example, people affected by such impairments of divided attention find it harder to turn in a crossroads and speak at the same time. These people therefore have a higher risk of an accident in such situations [43].

The stimuli a person is exposed to add up to cognitive stress. Cognitive stress generally describes the mental strain to which a person is exposed [45]. If we consciously expose ourselves to two stimuli or activities at once and work with them, this is referred to by many as multitasking. Multitasking describes the ability to fulfil the requirements of several tasks simultaneously [46]. Multitasking is also called "continuous partial attention" in the English technical literature. It means the capacity of a person to receive simultaneous and possibly different stimuli [47].

Salvucci [48] describes multitasking as several (sub)tasks that a person integrates and performs in the context of a larger, more complex task. At the most basic level, multitasking can consist of actions that are directly related and require simultaneous execution. An example of this is changing lanes with the car, where attention must be drawn to the other lane and the steering wheel turned at the same time. On a more complex level, the tasks are either independent or nested and in both cases take place simultaneously. An example would be changing the radio station in the car while turning the steering wheel in a curve [48].

In their study "The effect of multitasking on the grade performance of business students", Ellis, Daniels and Jauregui [49] examined the impact of multitasking in more detail. The study examined whether multitasking in the classroom influences students' grade performance. To this end, the researchers experimented with 62 students of economics. The students took part in a lecture for the experiment, then received a quiz on the content of the lecture. During the lecture, half of the participants were allowed to multitask in the form of texts with their mobile phones. The other half were concentrated completely on the lecture. The researchers came to the conclusion that the results of the students who were busy with texts were significantly lower than the results of the other student group. Based on this, the researchers concluded that multitasking during class had a significant impact on performance. The distraction of the students led to poorer performance in the tasks. A decisive factor for performance is the complexity of the task. In multitasking, the performance of people depends on the level of complexity of the task and the competence in each task [50]. When the performer is qualified in the task, he can perform these tasks with negligible impact on overall performance [50].

The more routinely an activity can be carried out, the greater the available knowledge and the easier it is to carry out other tasks. In addition, the perceived and sometimes real cognitive burden of a routine task is lower. Another example of this is reversing by car. Many drivers listen to the radio while driving. But most people switch the radio off as soon as they have to park backwards. This is because the forward driving routine allows the driver to listen to the radio while driving. However, reversing is usually not a routine procedure and therefore means a higher cognitive load than driving forwards. Therefore, the driver turns off the radio and eliminates any secondary activity to minimize cognitive stress. In general, the effect of reducing cognitive stress through routine is helpful because it allows us to do several things at once. However, this becomes dangerous if the true cognitive load is misinterpreted. If too little attention is paid to an activity, the risk of errors is much higher.

If driving has become a daily routine for a driver, he can no longer be aware of the true cognitive burden of driving. This phenomenon also occurs with drivers who are supposedly familiar with the route they have travelled. In addition, the feeling of routine as well as driving on known routes leads to a rapid loss of concentration of the driver [51] [52].

In the next section, the different types of distractions in road traffic and their influence on driving performance, traffic and accident risk will be discussed in more detail.

2.3 Distractions and their influence on the driving performance

As described in section 2.2, the AAA Foundation for Traffic Safety concluded a survey in 2012 where the majority of respondents saw a great danger in "distracted driving". An even greater portion of 95.4% think reviewing or updating social media or using other functions of mobile phones (66%) while driving causes a higher chance of accidents [52]. However, the study also concludes that there is a significant discrepancy between participants' concerns and actual behavior in traffic. Although most respondents rejected distracted driving habits, the survey found that they practice many of these behaviors themselves. More than one-third (34.6%) of respondents admitted to having read an email in the last 30 days while driving. One-quarter (26.6%) said they had written at least one text or email in the last 30 days. 68.9% of respondents had made at least one driving call in the last 30 days and almost a third (31.9%) admitted to doing so "quite often" or even "regularly". In addition, the NHTSA 2012 National Distracted Driving Attitudes and Behaviors Survey found that more than half (58%) of motorists surveyed continue their journey after receiving a call on their mobile phone [52] [53].

The impact of this behavior on road traffic is discussed in more detail in the next paragraph.

2.3.1 Distraction as a cause of accident

The influence of distractions can be seen in the accident statistics of recent years. In 2010, 3,267 people died in accidents on a US highway, where the cause of the accident was later attributed to the driver's distraction. In the same year, the total number of crash-related fatalities (32,367) reached its lowest level since 1949. The total number of accidents fell by 1.9% in the following year. The number of crash-related fatalities caused by driver distraction, on the other hand, rose by approximately 1.9% to 3,331 [54]. This means that around 10% of all crash-related fatalities were caused by driver distractions.

Stutts, Reinfurt, Staplin, et al. investigated in detail how large this proportion is for accidents without fatalities [55]. The researchers analyzed the data from Crashworthiness Data System (CDS) from 1995-1999. The CDS records accidents that are so serious that a vehicle has to be towed away from the scene of the crime. The analysis of the data showed that 8.3% of drivers were distracted by crash-involved vehicles. In 36% of the accidents, however, it was no longer possible to determine whether the driver had left the vehicle. If the distribution of accident causes is applied to the 36% of accidents whose cause is known, the figure rises to 12.9%. However, because there is no evidence to support this assumption, the researchers have made a more conservative assumption. They assumed that the percentage of distraction among drivers with unknown attention status was only half that of distraction among drivers with known attention status. With this conservative approach, the total share of distraction among crash-induced drivers is still about 10.6% [55] [56].

The researchers also carried out an analysis of the CDS data for the years 2000-2003. It was found that only 6.6% of crash-involved drivers were distracted during this period.

However, the number of accidents in which the driver's attention status was unknown at the time of the accident was 46%. It applied the same conservative assumption based on the distribution of accident causes during this period. Thus, for the period 2000-2003, the total proportion of distracted drivers involved in an accident was 10.4%.

Thus over the period from 1995 to 2003, the proportion of accidents caused by distracted driving which were so serious that at least one vehicle was towed away from the scene of the accident did not noticeably increase. If it is assumed that the transfer to accidents with unknown distraction status is correct, then the percentage of deflected crash-induced accidents in this period is 10.5% [55].

In addition to the proportion of accidents caused by driver distraction, the study of Stutts, Reinfurt, Staplin and Rodgman [55] also examined in detail the cause of distraction and how it has changed over time. In the 1995-1999 analysis of reported accident data, researchers found that about 70% of reported distractions were inside the vehicle. Passengers and audio equipment were the most common distractions. The remaining 30% were distractions outside the vehicle [55].

When analyzing the accident data for 2000-2003, the researchers concluded that only 23.7% of distractions were caused by factors outside the vehicle. In 20.8% of accidents, the driver's disabilities were caused by the occupant of the vehicle at the time of the accident. Furthermore, 5.2% were distracted by the use or grasping of objects, 3.7% by a moving object in the vehicle, 3.6% by the use of a mobile phone, 2.9% by the setting of radio/cassette/CD, 2.8% by eating or drinking, 1.5% by the setting of the air conditioning and 1% by smoking while driving. However, the analysis also revealed that many of the distractions were context-dependent on the driving situation and occurred primarily under certain external circumstances. For example, accidents related to the adaptation of audio equipment were more frequent at night. Distractions involving communication with other occupants were most likely to lead to accidents at intersections. Accidents caused by distractions with moving objects inside the vehicle, on the other hand, almost never occurred on flat roads [56] [57].

As described at the beginning, a great danger with many secondary activities is that the driver does not perceive them or no longer perceives them as distractions. In the following section, the distractions during routine journeys are examined in more detail.

2.3.2 Effect of distractions on driving behavior

In 2001, the Highway Safety Research Center at the University of North Carolina conducted an observational study to investigate how drivers behave in traffic. The study looked more closely at the types of activities that drivers perform while driving. For this purpose, the possible consequences of the activities on driving behavior were examined [56].

Seventy drivers have been selected for the study, who were recorded a week in their own vehicles on their normal journeys. About 10 hours of these journeys were recorded on video by the researchers. These videos have been analyzed to identify distracting side tasks and to analyze how often the driving activities have been carried out. The study concluded that the drivers performed a secondary activity about 29.7% of the driving time. About 15.3% of the filmed driving time was spent talking to a passenger. In addition to driving, the drivers were busy with eating, preparing or cleaning up food that was buried or falling down (4.6% of the recorded driving time), using a mobile phone (1.3% of the recorded driving time), setting audio devices (1.4% of the recorded driving time) and smoking (1.6%

of the recorded driving time). The last 3.8% of the driving time was divided between searching for objects and other sideline activities [56].

Sayer, Devonshire, and Flannagan (2005) carried out a similar experiment to investigate the distraction of the driver in a real situation. They observed samples of 5-second video clips taken by 36 drivers during routine drives. Their analysis was based on approximately 120 hours of driving time in 5-second video clips. The evaluation of the videos showed that 34% of the recorded time the drivers perform a secondary activity while driving. The drivers were either talking to the riders (15%), taking care of themselves (6.5%), using their mobile phones in their hands (5.3%) or eating and drinking (1.9%). This percentage distribution was found when all participants were considered regardless of their age. In a more detailed analysis, the researchers found that performing secondary activities decreased with the age of the driver. Younger drivers (average age 25 years) were more than twice as likely to be engaged in sideline activities than older drivers (average age 64 years) [58].

Both studies show that the primary-secondary activity when driving is talking to passengers. In both studies, drivers spent about 15% of their driving time talking to passengers. Both studies also came to the conclusion that drivers spent about 30% of their driving time in secondary occupations. Both studies examined driver behavior under normal driving conditions, which are covered by drivers in their everyday lives. Based on this percentage, car drivers are employed in a third of their daily journeys in secondary occupations and thus have a higher accident risk.

The effects this has on traffic and by how much the accident risk increases as a result of secondary employment will be discussed in the next section.

2.3.3 Analysis of the distraction for the increase of the accident risk

The Virginia Tech Transportation Institute (VTTI) conducted the 100-Car Naturalistic Driving Study for the NHTSA [59]. The researchers aimed to calculate a quota ratio that represents the relative risk associated with a particular secondary task. One hundred drivers were selected to commute daily in or around the northern Virginia/Washington, DC area. Each of these participants uses either their vehicle or a leased vehicle for their journey to work. The sample was limited to six vehicle types due to instrumentality issues. The group of participants had been chosen to include a disproportionate number of younger drivers between 18 and 25 years of age and drivers with high annual mileage. From other studies, these two groups were assigned the high accident probability, which was intended to maximize the potential for recording crashes and near-crash events for the experiment. In the course of the experiment, over a period of 12 to 13 months, depending on the participant, a total of over 2 million vehicle miles and around 43,000 hours of driving were recorded on video [59].

During this time 69 accidents, 761 near accidents, and about 20,000 baseline segments could be recorded. The baseline segments were randomly selected to represent normal, uneventful driving. During the analysis of the videos, the researchers came to the conclusion that 33% of the recorded accidents and 27% of the recorded near misses were caused by a secondary task [59]. Using the recorded near crash data and basic data, the researchers calculated the odds ratio. The odds ratio represents the relative risk associated with a secondary task. For this purpose, the researchers divided the secondary tasks into three categories based on the time the driver had to take his eyes off the road. Complex tasks required more than two keystrokes or glances off the road, thus increasing the risk of an accident. These activities include applying make-up and reaching for a moving object. Moderate secondary tasks, on the other hand, are tasks with a maximum of two keystrokes, for example. These activities include inserting a CD and cassette or eating while driving. The third category includes simple tasks that required at most a keystroke or a glance. Activities that belong to this category are the stopping of radio, drinking or smoking [59]. The researchers calculated the quota ratios for the categories. This resulted in a quota ratio of 3.1 for complex secondary tasks, 2.1 for medium secondary tasks and 1.0 for simple secondary tasks. This means that when performing a complex ancillary task, drivers have about three times the risk of being involved in an accident or near miss as drivers who do not perform a category ancillary task. For medium secondary tasks, there was about twice the risk of driving without secondary tasks. For simple secondary tasks, there was no significant increase in the crash and near-crash risk [59].

The results of the quota ratio suggest that the complexity of the secondary task influences the crash and near-crash risk. Based on these findings, the researchers performed additional analyses to identify the environmental conditions associated with distraction-related crashes and near-crashes.

For these analyses, they only considered the complex secondary tasks with increased quota ratios, which indicate an increased risk. They concluded that quota ratios increase further when certain additional conditions occur together with a complex secondary task performed by the driver. These conditions, which increase the risk of accidents, include: twilight and unlit darkness, rain, divided roads and roads with gradients (straight or curved). The fact that normally divided roads are considered to be safer than undivided roads supports the conclusion that the risk of an accident is significantly increased by the driver performing a secondary task.

The studies described in this section underline the importance of considering distraction as a separate problem that differs significantly from other categories of carelessness. To investigate in more detail how the driver's behavior increases the probability of an accident, observational studies that are as realistic as possible are of particular interest.

This paper examines a combination of possible distraction factors. These distraction factors are deliberately chosen in such a way that they reflect an easily conceivable scenario for the test persons, because they are conceivable in one form or another in most vehicles. The results make it possible to determine the accident risk of commuters who travel the same distance every day. The following chapter describes the test setup and how to perform the test.

3 The experiment design

As described in section 2.2, distractions when driving can be divided into different categories. Each distraction has a different effect on the driver while driving. This chapter describes the experiment that resulted from the literature research and is analyzed in this thesis.

3.1 Statement of the problem

In both Germany and the United States, human error is by far the most frequent cause of road traffic accidents (Germany: 91% [60], USA: 94% [61]). Alcohol, drugs, fatigue, inappropriate speed and distraction are common causes and key factors of human misconduct in road traffic. Contrary to the technical standards in cars, the behavior of the driver and the road users, which seems to be difficult to influence or optimize, is the most important factor. For more safety in road traffic, however, it is essential to sensitize all road users to safe behavior. The German Road Safety Council summarized this in a statement in 2010 that in addition to the technical and legal measures, the assumption of responsibility by road users but also by CEOs and politicians was indispensable [10]. The cornerstones of such a system must be safe roads and roadsides, acceptable speeds, safe vehicles and informed road users. To achieve this, the system must be designed to forgive human error as far as possible.

The increasing use of the car (see 2.1.1) and the extension of the daily distances travelled by many drivers (see 2.1.2) has led in recent years to many people spending more and more time in the car. Many drivers therefore try to use their time for other activities. Many of the driving behaviors that create intentional or unintentional distractions are not taken seriously by most drivers and are therefore not fully investigated. Telephoning at the wheel is one of the few side jobs while driving that is prosecuted in Germany and the USA. The desire for constant availability, for example, tempts drivers to take an interest in mobile phones in addition to driving. Mobile phone use (see 2.2.3) is only one of several factors that distract the driver's attention.

This master thesis examines risk factors that distract the driver while driving. Supposed secondary activities of everyday driving behavior can have fatal effects. Various studies have investigated the effects of various secondary occupations, such as telephoning [62] or listening the radio [38] [63]. Some driving activities that are not relevant to driving are already regarded as acceptable under common law by drivers and their danger is therefore no longer perceived. These include, for example, activities such as eating, smoking or selecting a radio station, which distract the driver from driving. For many commuters who drive a long distance to work every morning, it has often become routine to drink coffee or other beverages while driving.

This thesis analyzes the relationship between driver distractions and accident probability. The null hypothesis is that the main factor level in Table 1 has no influence on the driver's driving performance. The alternative hypothesis is that the main factor levels in Table 1 influence driving performance.

Table 1: Main factors of the experiment

	Factor	Levels
Main Factors	Hand-On-Wheel	One-Hand, Two-Hand
	Background-Noise	Silent, News and Music
	Weather	Rain, Snow with black ice

Then this study seeks to identify the influence of Age and Gender Blocking according to driving performance. Hence, the null hypothesis is that the blocking levels in Table 2 have no influence on the driver's driving performance. The alternative hypothesis is that the blocking factor levels in Table 2 influence driving performance.

Table 2: Blocking factors of the experiment

	Factor	Levels
Blocking Factors	Age	under 40 (18-40 years), over 40 (41-90 years)
	Gender	Female, Male

The survey and a driving simulation experiment will be conducted to investigate the effects of distracted driving behavior. It will be possible to determine the influence of a combination of everyday secondary activities on accident risk. Based on the results, a statement can be made about the extent to which certain driving behaviors increase the probability of driving errors.

In the next section, the procedure of the study will be described in general.

3.2 General description of the study

As explained in the introduction, there are studies that suggest that different forms of distraction and their combination have an impact on the driver's driving style. This thesis explores the magnitude of the negative effects of certain distraction factors and their combinations. The distraction factors that will be investigated in more detail are the background noise in the car, hand on wheel while driving, and different external weather conditions. The main factors are deliberately chosen so that they could occur in a large number of cars, as secondary occupations and circumstances on a daily commuter trip, for example. That is, a person who goes to work in all weather and drinks a to-go cup on the way. With the results, it will be possible to analyze the connection between driver distractions and to make statements about the accident probability of a driver who is exposed to these circumstances and secondary occupations.

In order to participate in this research project, respondents must be at least 18 years old. The experiment begins by first questioning all participants in the experiment in a survey. The survey examines the driving habits and behavior of the participants. The demographic data of the participants, such as age and gender, as well as a personal assessment of their own driving habits are asked. Subsequently, the participants take part in the second part of the experiment wherethe participants drive in a driving simulator. The experiment consists of 12 repetitions with the same driving environment in the simulator, which are performed in random sequence. In each repetition, a different combination of the above mentioned main factors will be performed.

A driving simulation aims to investigate the driving behavior of the individual with the distraction factors in different scenarios, such as braking events, signs and traffic rules. The experimental design allows a complete analysis of the performance of each participant under different types of conditions and different forms of distraction.

3.3 Participants

A total of 57 people participate in the survey and 20 finish the simulator experiment. Two groups are taken into account for the age of the participants and also for gender. Both groups are almost balanced in age and gender. The participants are recruited in personal contact at the University of Rhode Island campus and in Narragansett. Each participant is at least 18 years old and has a driving license. If a participant wears normal glasses while driving, he has to wear them during the experiment. All experiments are conducted in the Driving Simulation Lab at the University of Rhode Island.

3.4 IRB approval

The approval of the Institutional Review Broad (IRB) at the University of Rhode Island has been obtained to conduct the experiment (IRB1819-161). The IRB ensures that the rights and welfare of recruited individuals for research projects are protected. For approval, the IRB has been provided with the objective of the research, research design and methods, the location of the research, the number of participants, ways of recruiting, security and confidentiality procedures to ensure that the approach of the study complies with federal regulations, guidelines and procedures.

3.5 Survey about driving behavior

The survey on the general driving behavior of the individual test groups is carried out using the SurveyMonkey Internet service. Appendix A provides a printed version of the survey with the declaration of consent that the participants had to agree to.

Before they begin the survey, the respondent is given a short explanation of the procedure and confirms in the consent form that they agree to the collection of their data and participation in the study.

In the first part of the survey, the respondent is asked to assign themselves to an age group (under 40 years; over 40 years) and gender (male, female). Then the driving experience of the participant is queried by how long he has had a driving license (1-5 years, 6-10 years, over 10 years), how much he drives (more than once a day, once a day, twice a week, once a week twice a month, once a month, other) and how long on average per day (less than 30 minutes, 30 - 60 minutes, 1 - 2 hour, 2 - 4 hours, more than 4 hours). With reference to the later experiment in the driving simulator, each participant is then asked whether he is aware of any distracting behavior when driving. More precisely, he is asked whether he sometimes drives with only one hand on the steering wheel and whether he listens to music or the radio while driving. In the last question, the participant is generally asked whether he is aware of the fact that distracted driving increases the probability of an accident.

The survey later makes it possible to assign the participants to a certain group and to make general statements about the driving behavior of this group. With SurveyMonkey, the data could be downloaded directly into Excel for further analysis (see Appendix B).

The next section describes the test in the driving simulator in more detail.

3.6 The driving simulator experiment

The driving simulation experiment was developed to evaluate the effect of different forms of distraction while driving. In the following sections, the driving simulator itself and how the experiment was performed are described in more detail.

3.6.1 The driving simulator

A TranSim VS IV Driving Simulator (Model 03755) manufactured by L3 Corporation, as shown in Figure 4, is used for data acquisition.

Figure 4 View of the driving simulator

The simulator of the company L3 Corporation offers a high-precision virtual reality driving environment, which can be adapted in the form of scenarios and environments to different applications and dangerous situations. The TranSim VS IV driving simulator is a fixed-base simulator consisting of a regular driving module such as a car seat and steering wheel, and three-channel plasma screens. A driving situation is simulated for the driver by sitting in the driver's seat and looking out of the windshield. The three screens create a nearly 180° field of view on the LCD displays that combines the look and feel of a real vehicle with the environment of a laboratory. This structure is intended to convey the feeling of real driving to the test subjects. Adaptable scenarios make it possible to simulate different situations on the road under realistic conditions. In this way, it is possible to expose the participants to different demanding situations in a controlled environment without really putting them at risk. All participants can be confronted with the same scenarios and circumstances. The experiment can, therefore, be repeated for the participants without any risk and as often as they like, which ensures direct comparability of the results.

The driving simulator then makes it possible to carry out simulation-based training or experiments on different terrain, roads and environmental conditions. With the software Scenario Builder™, it is possible to design a custom-made scenario which is controlled by the L3 Communications - Operator Console (OPCON). An urban, suburban and rural road and traffic environment can be selected as well as mountains, highways, snowy roads and deserts. Vehicles and objects can be added to the scenario via the software. It is also possible to simulate changes to the vehicle, such as an engine fire. The weather conditions (rain, snow, ice and fog) and the lighting conditions (day, night or twilight) can also be changed.

The vehicle controlled in the scenario can choose from a variety of predefined vehicle configurations. The simulator cockpit (see Figure 5) has a driver's seat, steering wheel, brake pedal and accelerator pedal.

Figure 5: Cockpit of the driving simulators

It also includes an automatic transmission lever (ATL), indicator lever, a 3-point safety belt, and a speed and fuel gauge on the dashboard. The practical operation of the virtual car follows the same steps that are necessary for a real car.

The participants interact with the simulator via the integrated steering wheel and the pedals of a sedan. Both provide real-time feedback to the control computer. The test person's driving decisions are also transmitted in real time to the scientists' control computers. The software checks the driving performance and the reactions of the drivers. At the end of each driving scenario, the software outputs a protocol with the detected driving errors and a percentage evaluation of the driving style. The protocol is also called Driver Assessment. Each driver starts with 100% in Miscellaneous and 100% in Vehicle Handling Safety. The software assigns a certain percentage to each offense, which is subtracted from 100%. For example, High Speed Collision and Maximum Speed Limit Exceeded are rated at 5% each and Hard Braking at 3% and deducted from Vehicle Handling Safety. The driver in the experiment is not informed of the loss of points but can assume that the loss of points is equivalent to real traffic offenses. After the drive has been completed, the final value is given in the Driver Assessment as the driving performance value and output variable.

3.6.2 The experiment with the driving simulator

All experiments for the thesis were performed in the Driving Simulation Lab of the University of Rhode Island. With a separate program called Scenario Builder™, the scenario was developed and provided with the desired conditions. In order to carry out the experiment in such a way that it applies as universally as possible to many people who drive a lot, the scenario environment includes both main and secondary roads as well as highways (see Figure 6).

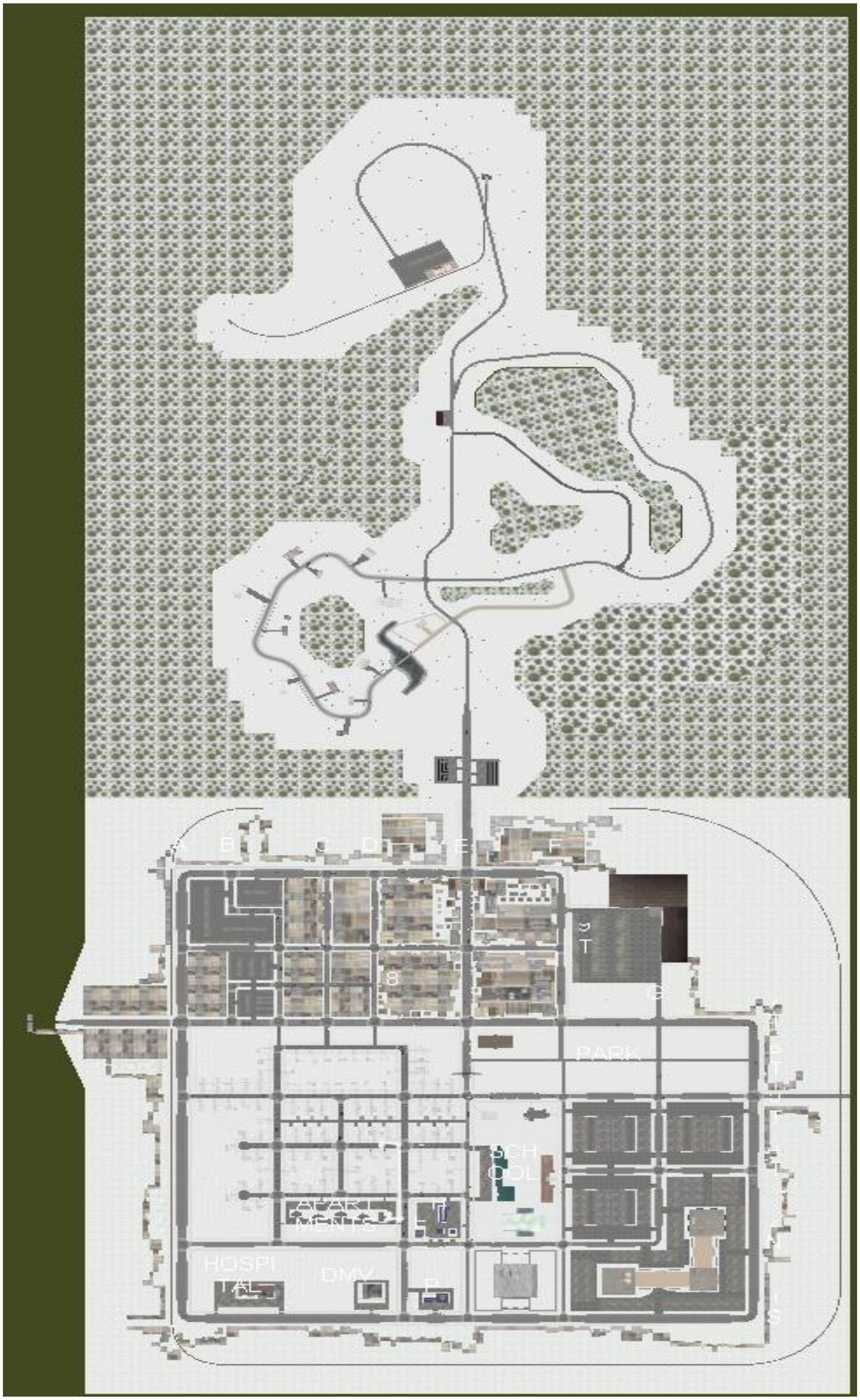

Figure 6: Map of the scenario environment on the driving simulator

The participants control a Ford Taurus (white, two-wheel drive) during the test.

As a road user, the participant drives together with other cars on the streets of the virtual city. Out of consideration for the participants and the computer capacity, pedestrians have been dispensed with at the expense of denser traffic. In this way, however, it is ensured that the moving car is almost always on the road with other road users.

The simulation experiment is divided into main factors and blocking factors (see session 3.2). From the main factors and their levels, 12 possible combinations result, which are run off in random sequence. The participants are informed at the beginning of each scenario about the distractions they are exposed to during the next scenario. Each participant drives four minutes in the driving simulator with each combination. The route that each driver took is freely chosen. In order to avoid a learning effect, the participants were instructed to drive a different route at each repetition. The speed could be determined by the drivers themselves, but the crossing of speed limit categories led to deductions in the Vehicle Handling Safety in the Driver Assessment of each trip. In addition to other cars, the road environment also included traffic lights, stop signs, left and right turns as well as signs indicating the respective speed limit. These objects had to be taken into account by the driver while driving. Other challenging situations arose through interaction with road users. By requiring active participation from the driver, we were able to get an evaluation of each driver's performance. Therefore, Aggressive Behavior for the other road users was set in the software. This resulted in situations where other road users suddenly overtook the simulation car, overtook stop signs, or were in the middle of the road and stopped driving. If the driver was not alert, collisions could not be avoided.

A major main factor of the experiment is the Background-Noise in the car. The car radio is simulated with a Bluetooth box with which the researchers play the corresponding background noise. YouTube Livestream is used to generate the Background-Noises levels, News and Music. In this way, Music and News are completely random. For Music the livestream "Best Radio Live Music Stream, Top Hits Pop Songs World 2019 Best English Songs 2019 Popular Songs" [64] is used and for News the livestream "DW News Livestream | Latest News and breaking stories Listen" [65]. The main factor Weather is controlled by the control computer. For the Hand-On-Wheel main factor, the participant holds a to-go coffee cup in his hand to make sure he does not put both hands on the steering wheel during the experiment. After each scenario, the researchers make sure that the participants are comfortable. If desired, they could take a break after each scenario.

In the next section, the design of the experiment with the driving simulator is described in detail.

3.7 Design of experiment

In the thesis the effects of distracting behavior during driving are examined. The driving simulation experiment has been developed to evaluate different forms of distractions and their combination while driving. The participants drive in the simulation as a car in suburban traffic. The factors investigated in the developed driving simulation experiment were divided into main factors and blocking factors (see Table 3).

Table 3: Main- and blocking factors of the experiment

	Factor	Levels
Main Factors	Hand-On-Wheel Background-Noise Weather	One-Hand, Two-Hand Silent, News and Music Rain, Snow with Black Ice
Blocking Factors	Age Gender	under 40 (18-40 years), over 40 (41-90 years) Female, Male

A total of three main factors and two blocking factors are measured. As shown in Table 3, Hand-On-Wheel, Background-Noise and Weather are defined as the main factors.

In Hand-On-Wheel, one-handed driving is compared to two-handed driving. Second, it examines the extent to which Background-Noise has an influence on the driver's driving behavior. Finally, the Weather is the third main factor, and the influence of weather conditions on driving performance is investigated.

In the survey (see session 3.5), participants will be divided into under 40 (18-40 years) and over 40 (41-90 years) age groups and two genders. Based on this, the age groups and the two gender groups become two blocking factors (Age and Gender) in the experiment. In the following sections, the level under 40 always mean 18-40 years, and over 40 means 41-90 years.

In the blocked factorial experiment design (Eq. (2)), the following model results with the three main factors and two blocking factors mentioned above:

$$Y_{ijkl} = \mu + \tau_i + \beta_j + \gamma_k + (\tau\beta)_{ij} + (\tau\gamma)_{ik} + (\tau\beta\gamma)_{ijk} + \delta_l + \upsilon_m + (\delta\upsilon)_{lm} + \varepsilon_{ijklm} \quad (2)$$

- μ: Mean of the Responses
- τ_i: Hand − on − Wheel ($i = 1,2$)
- β_j: Background − Noise (i=1,2,3)
- γ_k: Weather (k = 1,2)
- δ_l: Age ($18 - 40, 41 - 90$)
- υ_m: Gender ($Female, Male$)
- ε_{ijklm}: Error
- Y_{ijklm}: Driving Performance Score

The variables μ, τ_i, β_j and γ_k represent the effect of the main variables $(\tau\beta)_{ij}, (\tau\gamma)_{ik}$ and their triangular interactions and $(\tau\beta\gamma)_{ijk}$ the triangular interactions of the main factors. The effects of the blocking factors Age and Gender represent δ_l and υ_m. The variable $(\delta\upsilon)_{lm}$ is the interaction of the blocking factors ε_{ijklm} refers to the analysis error. And the variable Y_{ijklm} is the Driving Performance Score based on the driver assessment protocol of the driving simulator.

Based on the fact that the main factor Hand-On-Wheel has two levels, the main factor three Background-Noise has three levels and the main factor Weather has two levels, there are 12 combinations of the main factors (see Table 4).

Table 4: Combination of the main factors

Hand-On-Wheel	Background-Noise	Weather
2	1	1
1	2	2
2	3	1
2	2	1
2	1	2
1	3	2
1	2	1
1	1	1
2	3	2
2	2	2
1	1	2

Table 4 shows all of the main factors and the interaction between the main factors. For analysis, the block is considered the main effect, except that interactions between the block and the other main effects do not exist or are not investigated. All possible main factor combinations are assigned to each block during the experiment.

The results of this test make it possible to determine the results of the individual test runs and which main factors in which combination have the most significant influence on driving performance.

3.8 Measurement and collection of data sets

While the participants drive in the driving simulator, after 4 minutes a repetition is over and the researcher stops the scenario in the driving simulator. As described in section 3.4.1, the driving simulator outputs a Driver Assessment of the events in the simulator after each completed drive. The simulator software checks the driver's driving style and detects violations of the traffic rules. The Driver Assessment lists all violations of the traffic rules (see Figure 7).

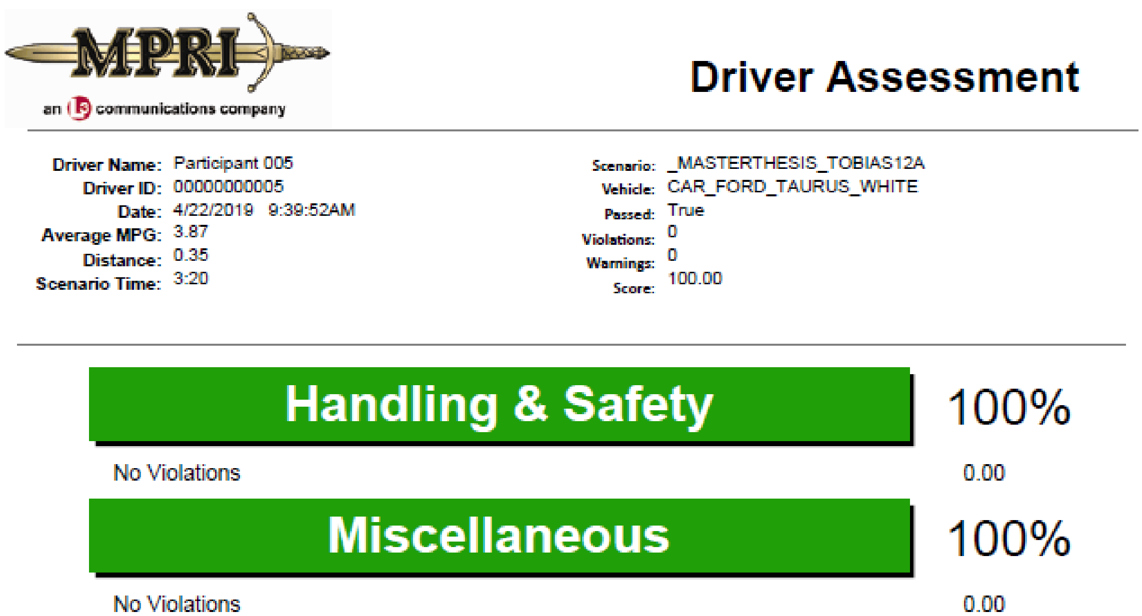

Figure 7: Driving assessment of the driving performance in the driving simulator. The driver had no violations of any traffic rules and got a perfect score.

As can be seen in Figure 7, the violations are assigned to either the Vehicle Handling Safety or the Miscellaneous category. In both categories, each driver starts with 100%. The driving assessment is saved for each repetition. This means that 12 driving assessments are stored per participant, from which the driving performance can be determined by the researchers. The procedure to determine the driving performance are descripted in the next sections.

3.8.1 Output factors of the driving simulator

The software of the driving simulator independently evaluates all offenses depending on the severity of the offense with a percentage number. Possible offenses that can be committed by the driver are Following too close, Speed Collision, Hard Braking Maximum or Maximum Speed Limit Exceeded. The software then calculates, for example, High Speed Collision or Maximum Speed Limit Exceeded with a 5% deduction in the category Vehicle Handling Safety. Less serious offenses such as Following too close and Hard Braking mean a deduction of 3% each in Vehicle Handling Safety. If the software detects a violation while driving, the percentage is deducted from the corresponding category. The percentage deduction is always the same for a particular violation. The final value is given in the Driver Assessment and is the automatically generated output variable of the driver's performance in the driving simulator (see Figure 8).

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Driver Assessment

Driver Name:	Participant 026	Scenario:	_MASTERTHESIS_TOBIAS12A
Driver ID:	000000000026	Vehicle:	CAR_FORD_TAURUS_WHITE
Date:	6/12/2019 3:56:02PM	Passed:	True
Average MPG:	7.64	Violations:	4
Distance:	1.50	Warnings:	0
Scenario Time:	4:03	Score:	86.00

Miscellaneous 100%

No Violations	0.00

Vehicle Handling Safety 86%

00:52 - Medium Speed Collision; Other Vehicle Speed =35	5.00
01:03 - Following too close; lead time=1 speed= 34 vehicle 186 Medium Snow	3.00
01:28 - Hard braking; Initial speed = 31.44 MPH	3.00
01:55 - Following too close; lead time=6 speed= 51 vehicle 1 Medium Snow	3.00

Figure 8: Driving assessment which shows the driving performance score after violations during the experiment

In Appendix B is a complete driver assessment. The problem with this evaluation, however, is that the simulator's evaluation of the violations does not always appear appropriate. For example, a High Speed Collision is a deduction of 5% in the category Vehicle Handling Safety (see Figure 9). The same number of points will also be deducted for Maximum Speed Limit Exceeded (see Figure 9).

Vehicle Handling Safety 79%

00:44 - High Speed Collision; Speed =48 (siren ON)	5.00
00:45 - Maximum Speed Limit Exceeded 45 should be 40 (siren ON)	5.00
00:53 - Low Speed Collision; Speed =14 (siren ON)	5.00
00:54 - Hard braking; Initial speed = 38.14 MPH	3.00
01:10 - Hard braking; Initial speed = 27.93 MPH	3.00

Figure 9: List of violations in the category Vehicle Handling Safety

Based on the consequences of both offenses for the driver and road safety, this evaluation does not seem appropriate. For this reason, the percentage in Vehicle Handling Safety and Miscellaneous is not used as a starting variable for this thesis.

3.8.2 Used output factor of the experiment

Instead of the percentage output variable in the driving assessment, a separate evaluation is defined for the experiment. The basis for the evaluation is the listed violations in the driving assessment. In this way, it is ensured that the trips continue to be evaluated neutrally and equally. It is assumed here that the driving simulator software always reports the same driving errors under the same circumstances.

In the course of the test, the offenses listed in Table 5 were detected by the simulator.

Table 5: Violations detected by the driving simulator

Violations	**Level of Violations**
Following too close	Speed < 30 mph, Speed > 30 mph
Hard Braking	Speed < 30 mph, Speed > 30 mph
Speed Collision	Low Speed, Medium Speed, High Speed
Maximum Speed Limit Exceeded	Speed < 9 mph, Speed > 10 mph
Too fast for weather conditions	Speed < 30 mph, Speed > 30 mph
Cab collided with a structure	Speed < 30 mph, Speed > 30 mph

The listed violations are evaluated on the basis of a new weighting. The Rhode Island Traffic Laws serve as the basis for this rating system. The proposed penalty is used as a distinguishing and weighting criterion. A legal sentence or the withdrawal of a driving license is considered to be more severe than a fine.

Table 6 shows which paragraphs of the Rhode Island Traffic Laws govern the violation and what penalties they impose.

Table 6: Traffic laws of the violations

Violations	Statute	Punishment
Following too close	RI Gen L §31-15-12 Interval between vehicles	$75.00
Hard Braking	2012 Rhode Island General Laws Title 31 - Motor and Other vehicles Chapter 31-27.1 - Aggressive Driving	"…not less than two hundred sixty dollars ($260) nor more than five hundred dollars ($500)." "…may be subject to a minimum thirty (30) days suspension of his or her driver's license."
Speed Collision	2012 Rhode Island General Laws Title 31 - Motor and Other vehicles Chapter 31-26 - Accidents and Accident Reports	Depends on the Damage
Maximum Speed Limit Exceeded	2005 Rhode Island Code - § 31-41.1-4 — Schedule of violations.	(A) One to ten miles per hour (1 - 10 mph) in excess of posted speed limit $85.00 (B) Eleven miles per hour (11 mph) in excess of posted speed limit with a fine of ten dollars ($10.00) per mile in excess of speed limit to be assessed $195.00
Too fast for weather conditions	RI Gen L § 31-14-1 (2013)	$85.00
Cab collided with a structure	2012 Rhode Island General Laws Title 31 - Motor and Other vehicles Chapter 31-26 - Accidents and Accident Reports Chapter 31-26-5 - Duty in accident resulting in damage to highway fixtures.	Depends on the Damage

From the penalty that the Rhode Island Traffic Laws sets for the violation, and the external circumstance, a penalty point number will be set for each violation. The penalty points form the evaluation system from which the new starting variable is calculated for each ride in the driving simulator.

First of all, it is determined for the evaluation that the same offenses receive more penalty points at higher speeds. On the other hand, this can be justified by the formulas for the braking distance (see Eq. (3)).

$$\text{Braking distance (in m)} \approx \left(\frac{\text{Speed } (v \; in \; m/h\,)}{10}\right) \text{x} \left(\frac{\text{Speed } (v \; in \; m/h\,)}{10}\right) \qquad (3)$$

For the braking distance, the speed v is the decisive factor for the distance until the car comes to a standstill. The higher the speed, the greater the risk that the car will not stop in time for a dangerous situation. Speed is also a decisive factor in a collision. The higher the speed of the car in a collision, the higher the force acting on it. The basis for this is the conservation of momentum theorem, which can be derived from Newton's Second and Third Axioms (see Eq. (4)).

$$Force\ (F) = \frac{Impulse\ (P)}{Time\ (t)} = \frac{Mass\ (m)\ x\ Speed\ (v)}{Time\ (t)} \qquad (4)$$

The equation (4) shows that for a car with the same Mass (m) and the same Time (t), the acting force increases in an accident with increasing speed. The force acting in an accident determines how the car and the object hit are impacted and thus the extent of personal injury or damage to property.

Then a distinction is made between two categories when assessing infringements. The first category includes infringements that are dangerous but do not directly involve personal injury or damage to property. These include, for example, violations such as Hard Braking or Following too close. On the other hand, there are offenses that directly involve personal injury or property damage, such as Speed Collision or Cab collided with a structure.

According to the Rhode Island Traffic Laws, the penalty level for Maximum Speed Limit Exceeded is divided into two levels. First, less than 10 mph above the respective speed limit and 10 mph above the speed limit (see Table 6). Even if the fine for speeding is high, only the driver of the car is involved. If the offense is considered in isolation, the possibility of an accident is not certain. In addition, driving a maximum of 9 mph above the speed limit applies to most drivers. For this reason, the offense will be assessed with 10 penalty points. Each speed violation of more than 10 mph will be assessed with 30 penalty points because fees for this violations based on Rhode Island laws are between two and three times higher (according to RI Gen L § 31-41.1-4). On the other hand, the general risk is significantly higher with increasing speed.

The same argument also applies to driving Too fast for weather conditions. It means a driving style does not suit the conditions on the road even if it is possibly within the rules that are otherwise prescribed on the road. RI Gen L § 31-14-1 (2013) sets a penalty of $85 for this offense. Since this is also consistent with the penalty for the first stage of speeding, the same penalty points are used for this offense.

Following too close, unlike driving too fast, means that the driver is on the road with another vehicle. In addition, the possibility of an accident is increased by driving too close, which makes an accident more likely. The fine for Following too close according to RI Gen L §31-15-12 is however comparable to the fine for Maximum Speed Limit Exceeded (maximum 9 mph above the speed limit). For this higher likelihood of an accident, Following too close (< 30 mph) is rated with 20 penalty points. Due to the great danger when driving faster, Following too close (> 30 mph) will be penalized with 30 points. The violation of Hard Braking (< 30 mph) will be judged with 30 penalty points. The evaluation is based on the assumption that inattentive driving has previously made hard braking necessary. Without braking, an accident would certainly have occurred with another road user or an object. Another conceivable reason for hard braking could also be Aggressive Driving, regulated in RI Gen L 31-27.1. This paragraph describes an aggressive driving style which endangers the driver and other road users. The proposed penalty is between $260 and $500. In addition, the driver's license may be revoked for 30 days. Even though Aggressive Driving has been chosen for the computer-controlled vehicles in the driven scenario (see section 3.5.2), it is assumed that the driving style of the vehicles in the simulation always complied with the traffic rules. This means that almost all accidents are due to behavior or late reaction on the part of the participant. The fact that only 30 penalty points are set for Hard Braking (Speed > 30 mph) is that a surprising reaction of a car on the road has led the driver to a stronger reaction in order to supposedly avoid an accident.

These violations Following too close, Hard Braking, Maximum Speed Limit Exceeded and Too fast for weather conditions are events in which no direct personal injury or property damage has occurred.

The violations Speed Collision and Cab Collided with a Structure on the other hand contain injury or property damage. Chapter 31-26 - Accidents and Accident Reports of the Rhode Island General Laws - Title 31 - Motor and Other vehicles regulates the behavior in the event of an accident. Even if no explicit penalty for a collision is determined, both events will be more difficult to evaluate than the events described before due to the resulting personal injury or damage to property. The Speed Collision is automatically converted by the software into the speed levels Low, Medium and High. The higher speed is also rated more heavily, resulting in the penalty point distribution: Low Speed (< 20 mph) 50 penalty points, Medium Speed (20 mph < Other Vehicle Speed < 36 mph) 60 penalty points and High Speed (35mph < Other Vehicle) 70 penalty points. Cab collided with a structure is categorized in the two levels Speed < 30 mph and Speed > 30 mph. The lower speed is set at 60 and the upper speed at 70 penalty points like the penalty points for the comparative Speeding Collision categories Medium and High Speed. This evaluation results in the following weighting of the violations in Table 7.

Table 7: Rating of the violations of the driving simulations to create an output variable

Violation	Level of the violation	Points for the Violation
Following too close	Speed < 30 mph Speed > 30 mph	10 20
Hard Braking	Speed < 30 mph Speed > 30 mph	15 30
Speed Collision	Low Speed (< 20 mph) Medium Speed (20 mph < Other Vehicle Speed < 36 mph) High Speed (35 mph < Other Vehicle)	35 45 55
Maximum Speed Limit Exceeded	Speed < 9 mph Speed > 10 mph	10 30
Too fast for weather conditions	Speed < 30 mph Speed > 30 mph	10 30
Cab collided with a structure	Speed < 30 mph Speed > 30 mph	45 55

The points for the offenses are summed for eachrun and form as a sum the initial variable of the experiment repetition. This initial variable is used to evaluate the experiment. In the next chapter, the experiment with the initial variable is evaluated and it is determined which main factors have the greatest influence on driving performance.

4 Results and analysis

This chapter presents the results of the survey and the experiment. After a description of the collected data, the collected data are statistically analyzed.

4.1 Results of the survey

The survey had 57 participants. The results of the survey are summarized in Table 8.

Table 8: Result of the survey

Items	Classification	Sample amount	Percentage
Agree to participate	Yes	57	100.00%
	No	0	0.00%
Age	under 40 (18-40 years)	22	38.60%
	over 40 (41-90 years)	38	61.40%
Gender	Female	28	49.12%
	Male	29	50.88%
How many years have you had your driver's license?	1-5 years	8	14.04%
	6-10 years	12	21.05%
	over 10 years	37	64.91%
How often do you drive?	More than once a day	41	71.93%
	Once a day	3	5.26%
	Twice a week	8	14.04%

	Once a week	4	7.02%
	Twice a month	1	1.75%
	Once a month	0	0.00%
	Other	0	0.00%
How much time do you spend driving an average per day?	Less than 30 minutes	14	24.56%
	30 - 60 minutes	28	49.12%
	1 - 2 hour	8	14.04%
	2 - 4 hours	7	12.28%
	more than 4 hours	0	0.00%
Are you aware of behavior that distract you from driving?	Yes	53	92.98%
	No	4	7.02%
Do you sometimes only have one hand on the steering wheel while driving?	Yes	52	91.23%
	No	5	8.77%
Do you mostly listen to music or radio while driving a car?	Yes	51	89.47%
	No	6	10.53%
Are you aware that distracted driving increases the likelihood of an accident?	Yes	57	100.00%
	No	0	0.00%

Of those surveyed, 29 were men (49.12%) and 28 women (50.88%). The participants had to be in the age group under 40 (18-40) or over 40 (41-90). Of the respondents, 22 (38.60%) said they were between 18-40 (under 40) and 35 (61.40%) between 41-90 (over 40) years of age. When asked how long the participants owned their Driver's License, 8 (14.04% total) responded that they had their license between 1-5 years and 12 (21.05% of total) between 6-10 years. Thirty-seven (64.91% of the total) participants have their Driver's License for more than 10 years.

In the next questions the participants were asked how often they drive a car. On this question the participants could choose between more than once a day, once a day, twice a week, once a week, twice a month, once a month and others. The answers were divided as shown in Figure 10.

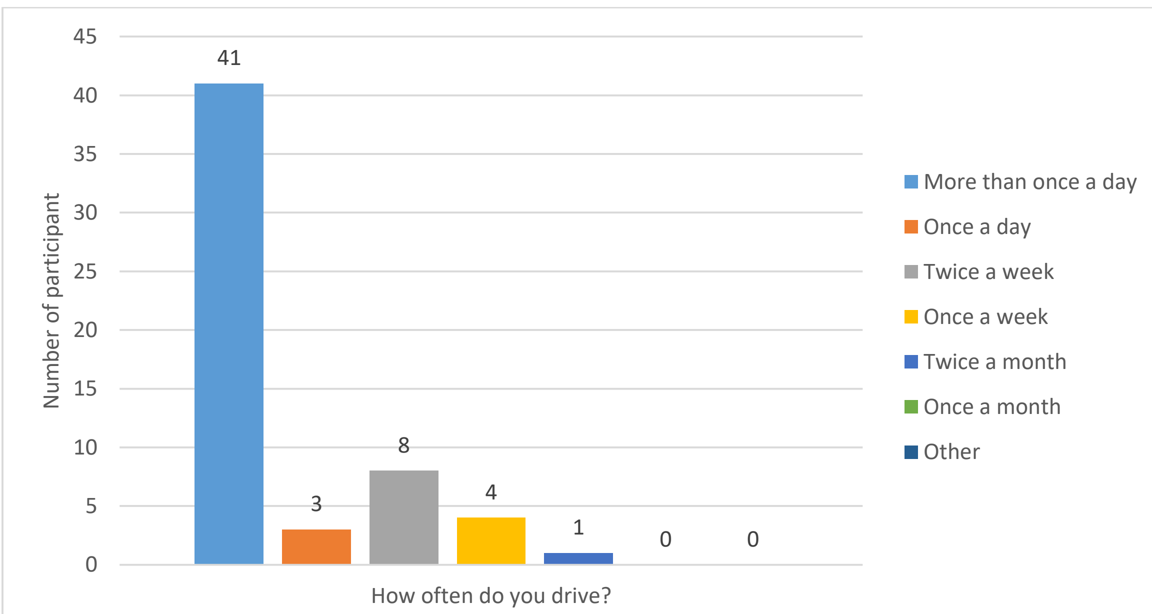

Figure 10: Result of the survey question: How often do you drive?

In the following question the participants were asked how long the participants drive on average per day. The participants could choose between less than 30 minutes, 30 - 60 minutes, 1 - 2 hours, 2 - 4 hours and more than 4 hours. The distribution of answers is shown in Figure 11.

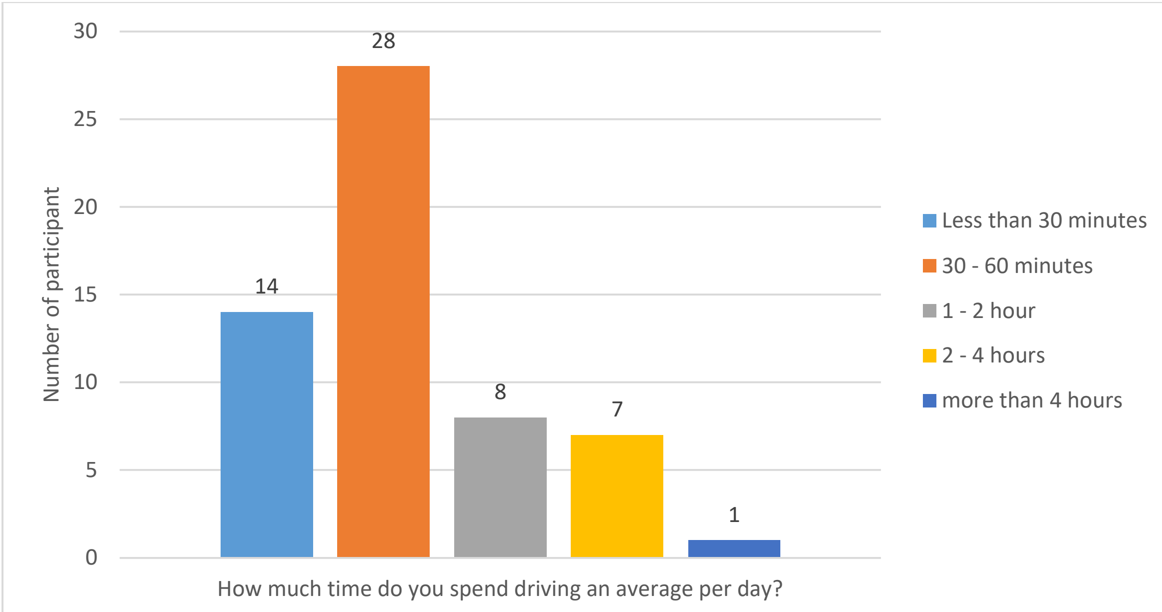

Figure 11: Result of the survey question: How much time do you spend driving an average per day?

Fifty-three of the respondents (92.98%) were aware of driving behavior that distracts them from driving. In addition, 52 of the respondents (91.23%) stated that they sometimes only had one hand on the steering wheel while driving and 51 of the respondents (89.47%) mostly listened to music or radio while driving. As a result, the minority (7.02% or 4 respondents) were not aware of any distracting behavior while driving and only 5 (8.77%) had their hands at the wheel at all times while driving and only 6 (10.53%) heard no music while driving.

In the last question, the participants were asked whether they were aware that distracted driving increases the probability of an accident. All respondents answered yes to this question.

The survey is a general statement about the participants in the experiment. Over 60% of the participants have had their driver's license longer than ten years and over 80% of the participants use their car at least a few times a week. Only a quarter (24.56%) of participants spend 30 minutes or less a day driving. All other participants spend more time in the car. In addition, almost all participants indicated that they listen to music or the radio (89.47%) while driving, or sometimes drive with one hand (91.23%).

In summary, the overwhelming majority participants are experienced drivers with enough driving experience who, however, have the potential to be affected by the main factors of the experiment, such as one-handed driving, even in a real situation.

4.2 Results of the experiment

The experiment described in chapter 0 aims to identify possible significant factors and interactions of distractions on driving performance. Design of Experiment (DOE) is used to systematically uncover the relationship between input factors and responses. Statistical methods are used to analyze data and to predict the performance of the factors under all possible conditions within the limits chosen for the designed experiment. In addition to understanding how a combination of factors affects the responses, the influences of interactions between different factors are also identified. Designed experiments provide a procedure to obtain the necessary information with a minimum of experiment runs.

In this section, the results are generally described in more detail. The raw data that is used in the following sections can be found in Appendix C.

4.2.1 Descriptive analysis for responses

This experiment with the driving simulator seeks to identify the three main factors with their levels: Hand-On-Wheel (One-Hand, Two-Hand), Background-Noise (Silent, Music, News), and Weather (Rain, Snow) that made 12 combinations of factor-level treatments. A total of 20 participants completed the 12 repetitions in the driving simulator. The 12 replications which each participant made, lead to a total number of responses of 240 (see Table 9).

Table 9: Descriptive analysis of the experiment [created with Minitab]

Responses	
Mean	37.31
Standard Error	2.55
Median	30
Mode	0
Standard Deviation	39.51
Sample Variance	1561.68
Range	300
Minimum	0
Maximum	300
Count	240

The sample mean of the response is 37.31, the sample median is 30 and the sample standard deviation of the responses is 39.51. Based on the fact that the sample mean is slightly larger than the median, it can be concluded that the data distribution is positively skewed. Furthermore, the standard deviation of the experiment suggests that there are slight large deviations in the responses. The larger standard deviation shows the larger dispersion of the responses. Nevertheless, the responses of the participants range from a minimum value of 0 to a maximum value of 300. The clustered bar chart in shows a representation of the distribution of numerical data.

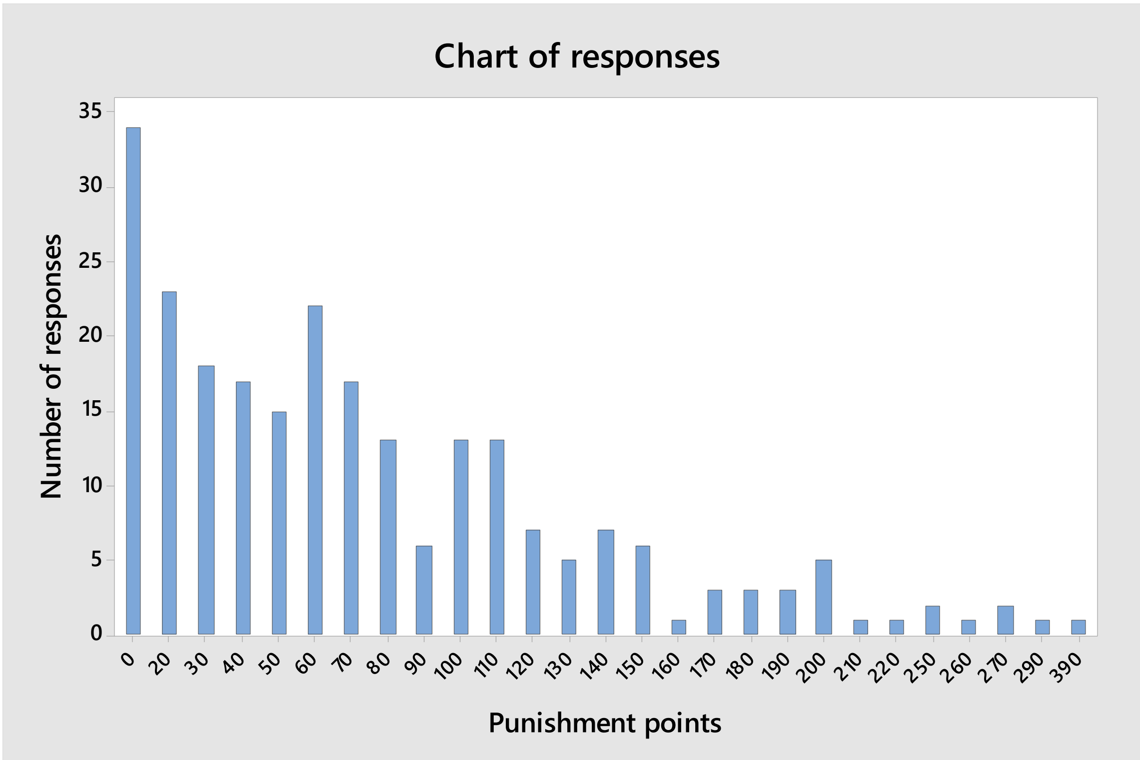

Figure 12: Chat of responses of the experiment [created with Minitab]

With this representation of the repetitions in chart categories, it is possible to compare the values. Based on the histogram, the majority of the responses are relatively close together, but outliers are also showing what was to be expected with the large standard deviation.

4.2.2 Check normality plot

The following Figure 13 shows the probability plot of the output variables of the experiment.

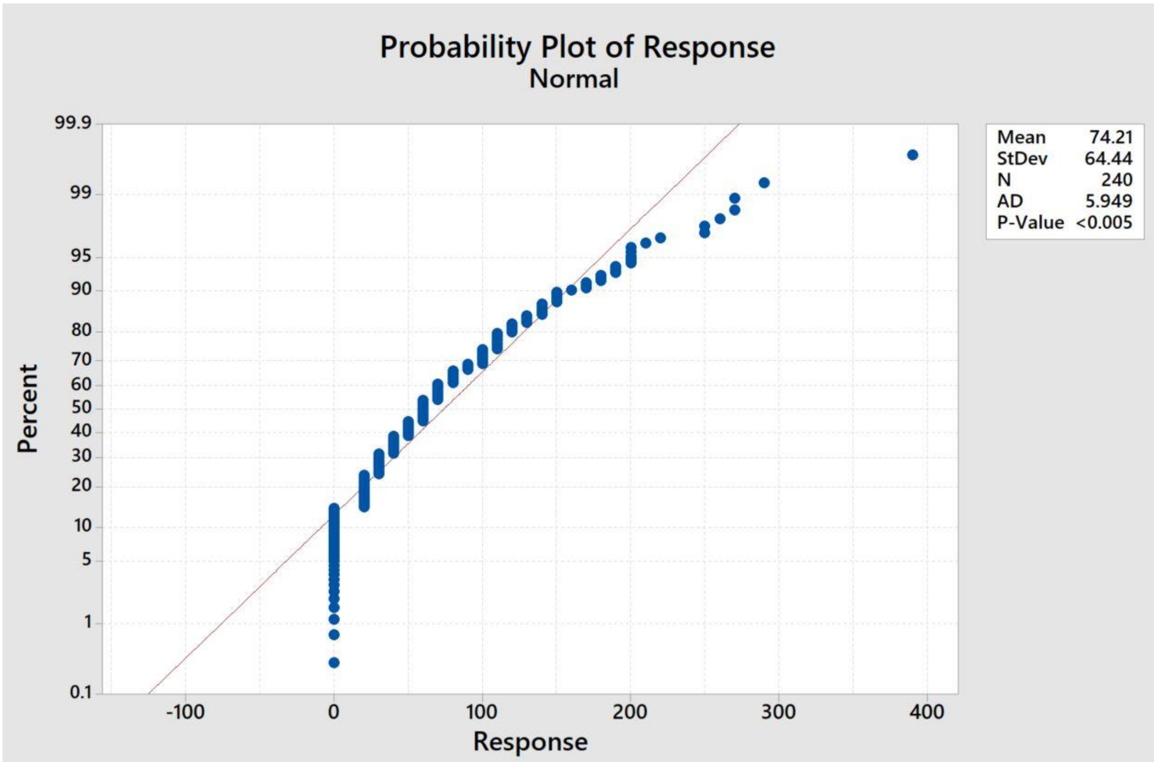

Figure 13: Probability plot of the responses [created with Minitab]

The normality test hypothesis assumed the null hypothesis H_0: data are normally distributed versus the alternative hypothesis H_1: data are not normally distributed. The normality test gives a p-value < 0.005 (see Figure 13). The p-value < 0.05 applies and the hypothesis H_0 at 5% level of significance is rejected. This means that the data responses are not normally distributed.

In the following section, the responses are analyzed with the Analysis of Variance (ANOVA).

4.3 Analysis of the experimental results

After collecting the data, the results of the experiment are presented and analyzed in this section. The Minitab statistics software is used for analysis. With Minitab, statistical data can be analyzed and graphically displayed in diagrams. Minitab is used to perform an Analysis of Variance (ANOVA). The results are summarized in an ANOVA table. With this table it is possible to determine which of the main factors and interactions are significant and influence the responses. This experiment is followed by a complete factor analysis. The analysis of the experiment in this thesis is performed in two parts. In the first part, the analysis is performed with the unmodified responses. In the second part, the analysis is done again, but this time all zeros in the responses variables are removed.

4.3.1 Analysis with unmodified responses

In this section, the responses of the Design of Experiment are analyzed to determine which key factors and interactions are significant and influence the responses. An ANOVA is performed using the Hand-On-Wheel main factor (One-Hand, Two-Hands), Background-Noise (Silent, Music, News), and Weather (Snow, Rain). The Age and Gender of the participants are treated as blocking factors. The blocking factors Age are divided into Age (under 40 and over 40) and Gender (Male and Female). The response of all drives in the driving simulator is the sum of the punishment points from the test repetitions and is called driving performance. The higher the sum of the punishment points, the more violations have been committed in the repetitions and the worse the driving performance.

A Pareto diagram of the main factors and blocking factors gives an estimate of the relative importance of the main factors and interactions that influence the responses of the experiment. Figure 14 shows which of the main factors have the greatest influence on the responses. For the experiment of this thesis, the Pareto diagram shows that the main factor Background-Noise is the only one that has a significant influence on the driving performance (see Figure 14).

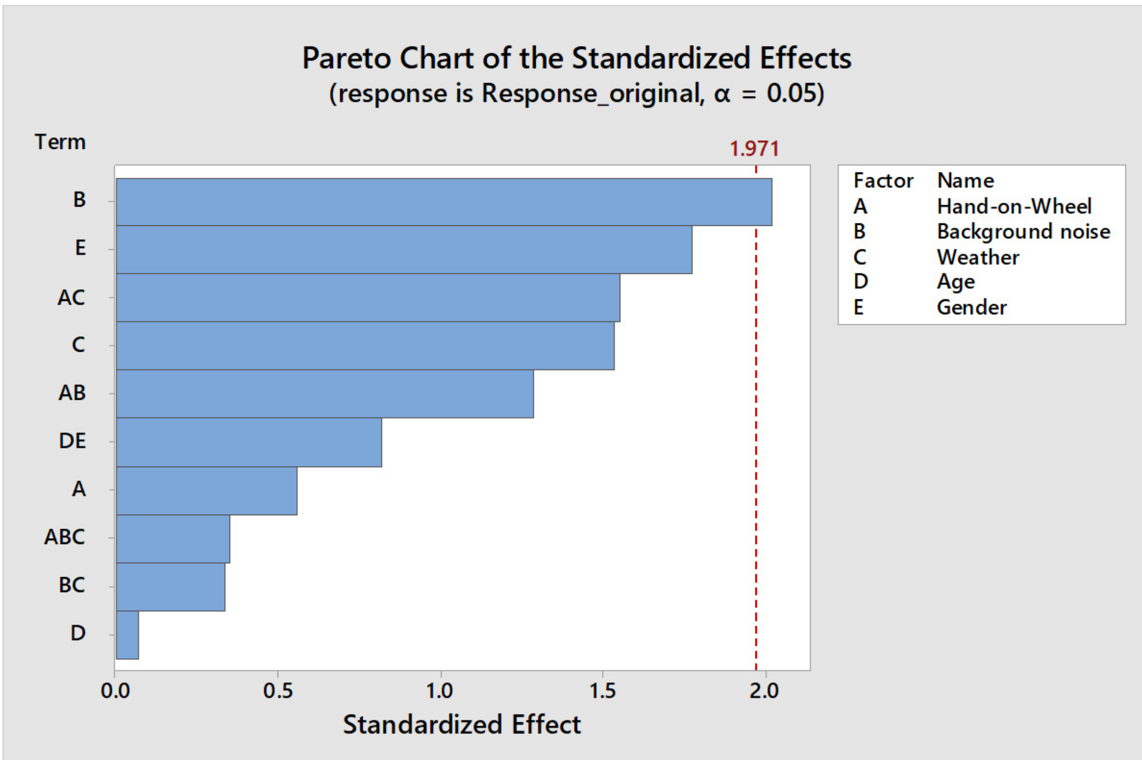

Figure 14: Pareto chart of the experiment [created with Minitab]

With the ANOVA, the input variables are examined more closely in order to check their significance and to identify the essential factors (main and interaction factors). All factors with a p-value at $\alpha=0.05$ are considered significant for the output variable. Table 10 shows the ANOVA table of the experiment.

Table 10: ANOVA table of the experiment with the unmodified responses

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Hand-On-Wheel	1	1260	1260.4	0.31	0.578
Background-Noise	2	25556	12777.9	3.15	0.045
Weather	1	9500	9500.4	2.34	0.127
Age	1	20	20.4	0.01	0.944
Gender	1	12760	12760.4	3.15	0.077
Hand-On-Wheel*Background-Noise	2	13151	6575.4	1.62	0.200
Hand-On-Wheel*Weather	1	9754	9753.7	2.40	0.122
Background-Noise*Weather	2	2476	1237.9	0.31	0.737
Age*Gender	1	2734	2733.7	0.67	0.413
Hand-On-Wheel*Background-Noise*Weather	2	2627	1313.7	0.32	0.724
Error	225	912610	4056.0		
Lack-of-Fit	33	102690	3111.8	0.74	0.850
Pure Error	192	809920	4218.3		
Total	239	992450			

The ANOVA analysis shows that based on the p-values in the ANOVA table, only the input variable Background-Noise with the p-value = 0.045 indicates statistical significance. The blocking factor Gender has a p-value of 0.077 and is therefore marginally significant. All other main factors and possible interaction factors are not statistically significant due to their p-value and will therefore not be investigated further.

With the Coefficient Table, the significance of the individual levels of the significant input factors can be examined more closely (see Table 11).

Table 11: Coefficients of the experiment with the unmodified responses [created with Minitab]

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	74.21	4.11	18.05	0.000	
Hand-On-Wheel					
One-Hand	2.29	4.11	0.56	0.578	1.00
Two-Hands	-2.29	4.11	-0.56	0.578	*
Background-Noise					
Music	14.54	5.81	2.50	0.013	1.33
News	-8.33	5.81	-1.43	0.153	1.33
Silent	-6.21	5.81	-1.07	0.287	*
Weather					
Rain	-6.29	4.11	-1.53	0.127	1.00
Snow	6.29	4.11	1.53	0.127	*
Age					
over 40	0.29	4.11	0.07	0.944	1.00
under 40	-0.29	4.11	-0.07	0.944	*
Gender					
Female	-7.29	4.11	-1.77	0.077	1.00
Male	7.29	4.11	1.77	0.077	*
Hand-On-Wheel*Background-Noise					
One-Hand Music	-0.29	5.81	-0.05	0.960	1.33
One-Hand News	-8.92	5.81	-1.53	0.127	1.33
One-Hand Silent	9.21	5.81	1.58	0.115	*
Two-Hands Music	0.29	5.81	0.05	0.960	*
Two-Hands News	8.92	5.81	1.53	0.127	*
Two-Hands Silent	-9.21	5.81	-1.58	0.115	*
Hand-On-Wheel*Weather					
One-Hands Rain	-6.37	4.11	-1.55	0.122	1.00
One-Hand Snow	6.37	4.11	1.55	0.122	*
Two-Hands Rain	6.37	4.11	1.55	0.122	*
Two-Hands Snow	-6.37	4.11	-1.55	0.122	*
Background-Noise*Weather					
Music Rain	-2.21	5.81	-0.38	0.704	1.33

Music Snow	2.21	5.81	0.38	0.704	*
News Rain	-2.33	5.81	-0.40	0.689	1.33
News Snow	2.33	5.81	0.40	0.689	*
Silent Rain	4.54	5.81	0.78	0.436	*
Silent Snow	-4.54	5.81	-0.78	0.436	*
Age*Gender					
over 40 Female	-3.37	4.11	-0.82	0.413	1.00
over 40 Male	3.37	4.11	0.82	0.413	*
under 40 Female	3.37	4.11	0.82	0.413	*
under 40 Male	-3.37	4.11	-0.82	0.413	*
Hand-On-Wheel*Background-Noise*Weather					
One-Hand Music Rain	-4.37	5.81	-0.75	0.453	1.33
One-Hand Music Snow	4.37	5.81	0.75	0.453	*
One-Hand News Rain	0.75	5.81	0.13	0.897	1.33
One-Hand News Snow	-0.75	5.81	-0.13	0.897	*
One-Hand Silent Rain	3.62	5.81	0.62	0.534	*
One-Hand Silent Snow	-3.62	5.81	-0.62	0.534	*
Two-Hands Music Rain	4.37	5.81	0.75	0.453	*
Two-Hands Music Snow	-4.37	5.81	-0.75	0.453	*
Two-Hands News Rain	-0.75	5.81	-0.13	0.897	*
Two hands News Snow	0.75	5.81	0.13	0.897	*
Two-Hands Silent Rain	-3.62	5.81	-0.62	0.534	*
Two-Hands Silent Snow	3.62	5.81	0.62	0.534	*

The ANOVA table in Table 11 above shows that the level Music for the main factor Background-Noise is the significant factor for the responses with p-value is 0.013. The blocking factor Gender has the p-value=0.077. In the next section, the blocking factor Gender is analyzed.

4.3.1.1 Analysis of the blocking factor Gender and unmodified responses

In order to analyze more precisely whether certain main factors may have a particular significance for the blocking factor Gender, the responses are divided into two data sets. One data set is Male and the other is Female. The previous analysis showed that the blocking factor Gender approximately has a significant effect on the responses. In this analysis of the divided data sets the main factors Hand-On-Wheel (One-Hand and Two-Hands), Background-Noise (Silent, Music, News) and Weather (Snow, Rain), their combinations and the blocking factor Age (under 40, over 40 years) are analyzed.

First, the Table 12 shows the descriptive statistics of the responses of the blocking factors Gender: Male.

Table 12: Descriptive Statistic of the unmodified responses in the data set Male [created with Minitab]

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Responses	120	0	81.50	5.68	62.22	0.00	40.00	70.00	110.00	290.00

Table 12 shows that the total number of responses is 120 and the Mean of this data set is 81.50. The range is from zero to 290 punishment points. The distributed responses of the data set Male is shown in Figure 15.

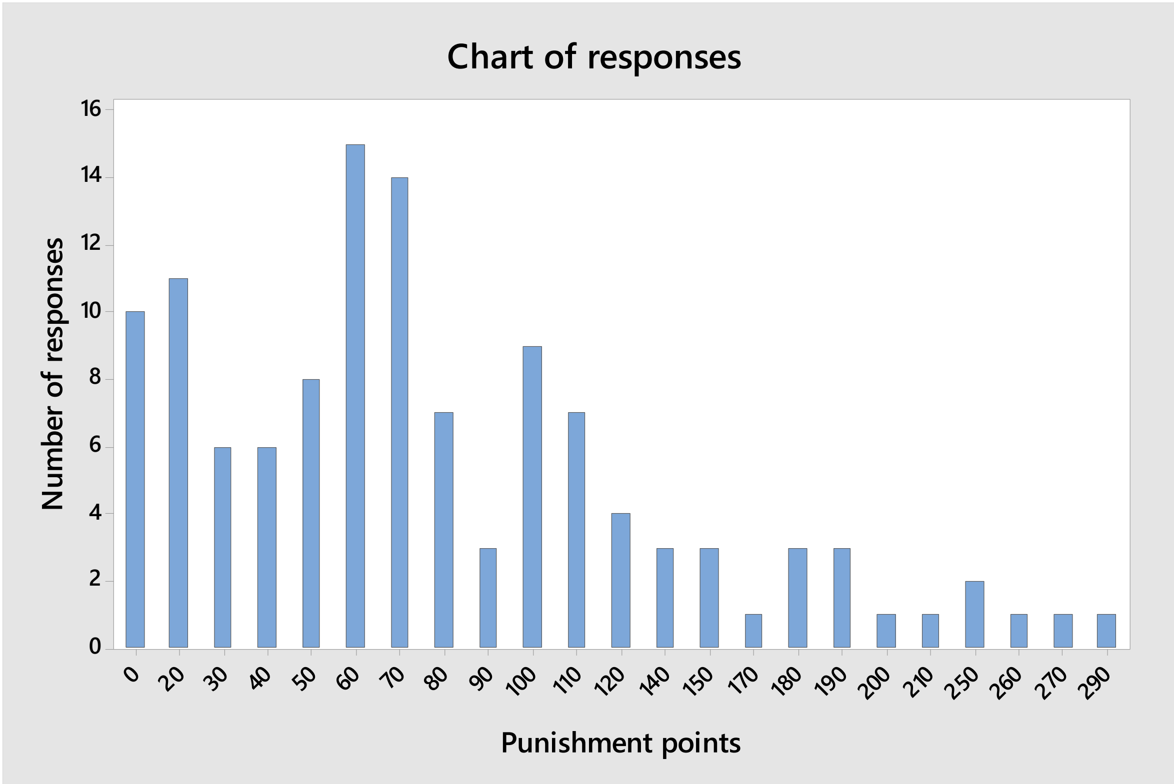

Figure 15: Chart of unmodified responses for the data set Male [created with Minitab]

Then the significant factors for the responses of this data set are examined. Figure 16 shows the Pareto diagram of the main factors, the blocking factor and the unmodified responses.

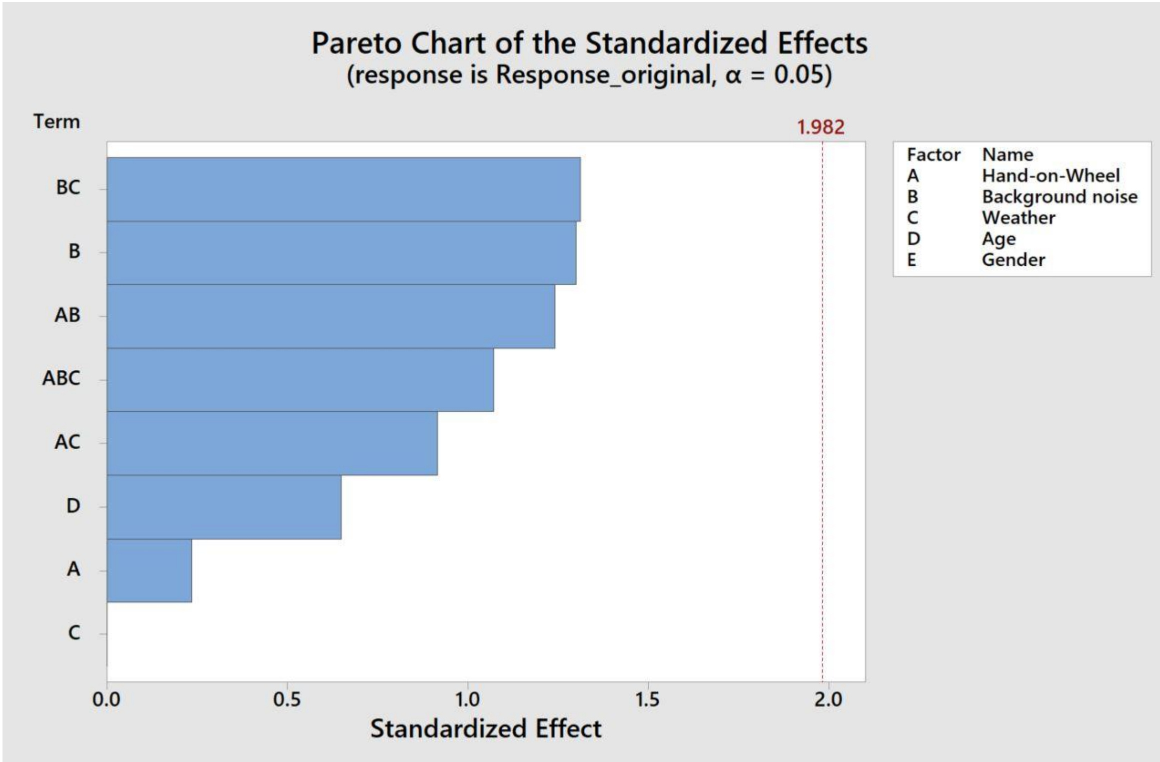

Figure 16: Pareto chart of the unmodified responses of data set Male [created with Minitab]

The Pareto diagram gives an estimate of the relative importance of the main factors and interactions that have the greatest influence on the initial behavior of the data set Male. For this data set, the Pareto diagram shows that no factor has a significant influence on the driving behavior (see Figure 16). The ANOVA Table (see Table 13) of this data set also shows that no factors seem to have a significant impact on this group.

Table 13: ANOVA Table of the unmodified responses of data set Male [created with Minitab]

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Hand-on-Wheel	1	213	213.33	0.06	0.814
Background noise	2	12635	6317.50	1.65	0.196
Weather	1	0	0.00	0.00	1.000
Hand-on-Wheel*Background noise	2	11832	5915.83	1.55	0.217
Hand-on-Wheel*Weather	1	3203	3203.33	0.84	0.362
Background noise*Weather	2	12795	6397.50	1.67	0.192
Hand-on-Wheel*Background noise*Weather	2	9672	4835.83	1.27	0.286
Age	1	1613	1613.33	0.42	0.517
Error	107	408767	3820.25		
Lack-of-Fit	11	13567	1233.33	0.30	0.985
Pure Error	96	395200	4116.67		
Total	119	460730			

Then, the significant factors for the second data set are analyzed. Table 14 shows the descriptive statistics of the responses of the data set Female.

Table 14: Descriptive Statistic of the unmodified responses in the data set Female [created with Minitab]

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Responses	120	0	66.92	6.03	66.04	0.00	20.00	50.00	110.00	390.00

The data set Female also has a total number of 120 responses. The Mean of these responses is 66.92 and the range is from zero to 390 punishment points. The distribution of the responses are shown in Figure 17.

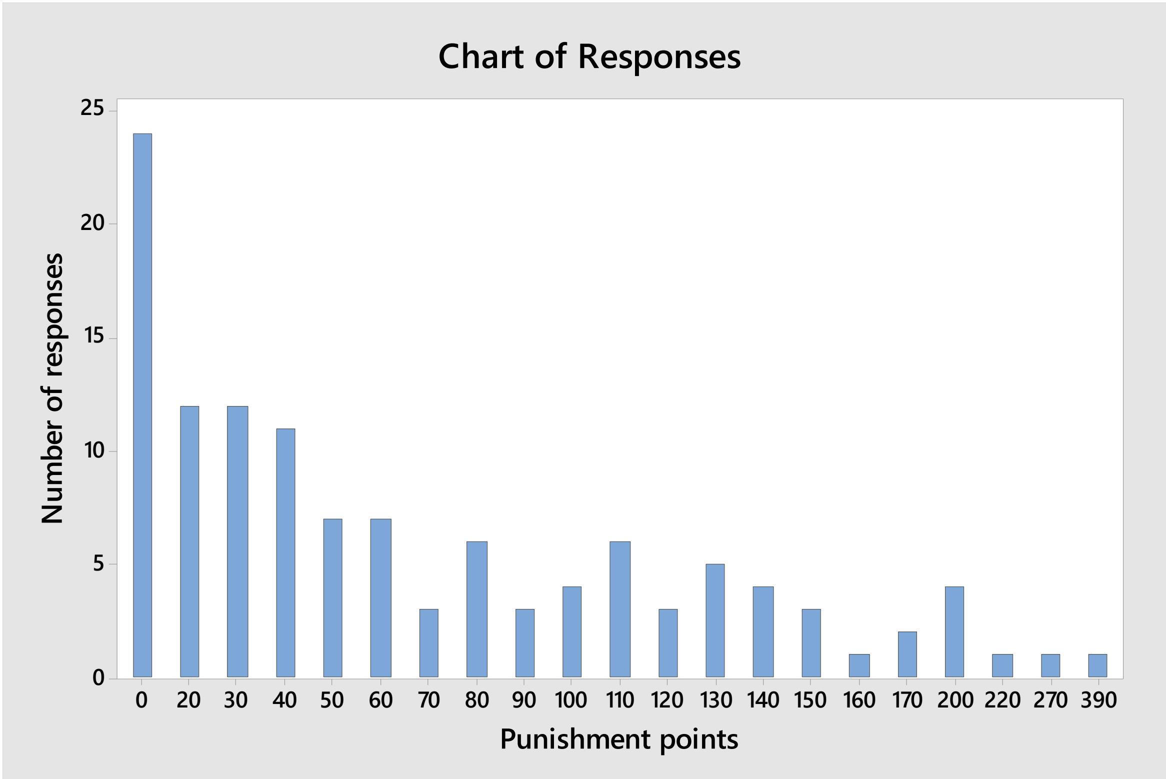

Figure 17: Chart of unmodified responses for the data set Female [created with Minitab]

Figure 18 shows the Pareto diagram of this analysis of the unmodified responses with the analyzed factors.

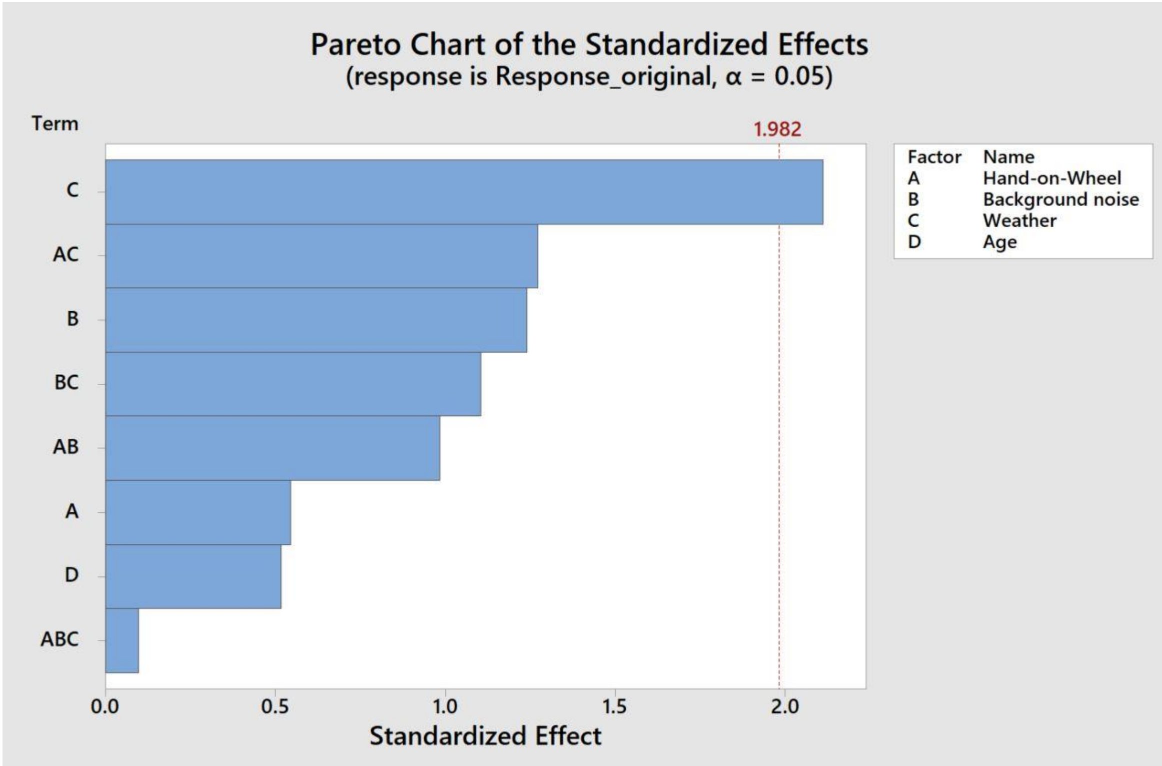

Figure 18: Pareto chart of the unmodified responses of data set Female [created with Minitab]

The unmodified responses of the data set Female are analyzed with the main factors, the interactions of the main factors and the blocking factor Age. The Pareto diagram shows that the main factor Weather is the only one that has a significant influence on driving behavior (see Figure 16). Table 15 shows the ANOVA Table of this analysis.

Table 15: ANOVA Table of the unmodified responses of data set Female [created with Minitab]

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Hand-on-Wheel	1	1267	1267.5	0.30	0.587
Background noise	2	13207	6603.3	1.55	0.217
Weather	1	19001	19000.8	4.46	0.037
Hand-on-Wheel*Background noise	2	9620	4810.0	1.13	0.327
Hand-on-Wheel*Weather	1	6901	6900.8	1.62	0.206
Background noise*Weather	2	11247	5623.3	1.32	0.271
Hand-on-Wheel*Background noise*Weather	2	687	343.3	0.08	0.923
Age	1	1141	1140.8	0.27	0.606
Error	107	455889	4260.6		
Lack-of-Fit	11	41169	3742.7	0.87	0.575
Pure Error	96	414720	4320.0		
Total	119	518959			

The ANOVA Table also shows that the main factor Weather is the only significant factor with a p-value of 0.08.

4.3.2 Analysis with modified responses

In this analysis, the main factors Hand-On-Wheel (One-Hand, Two-Hands), Background-Noise (Silent, Music, News) and Weather (Snow, Rain) with the blocking factors Age (under 40, over 40 years) and Gender (Male, Female) are analyzed. But in the responses, all outliers are eliminated downwards. This means that all responses that have a zero response are not included in the analysis. As in the previous section, the responses of the experimental design are analyzed with the ANOVA in Minitab to determine which main factors and interactions are significant and influence the responses. Figure 19 shows the Pareto chart of standardized effects.

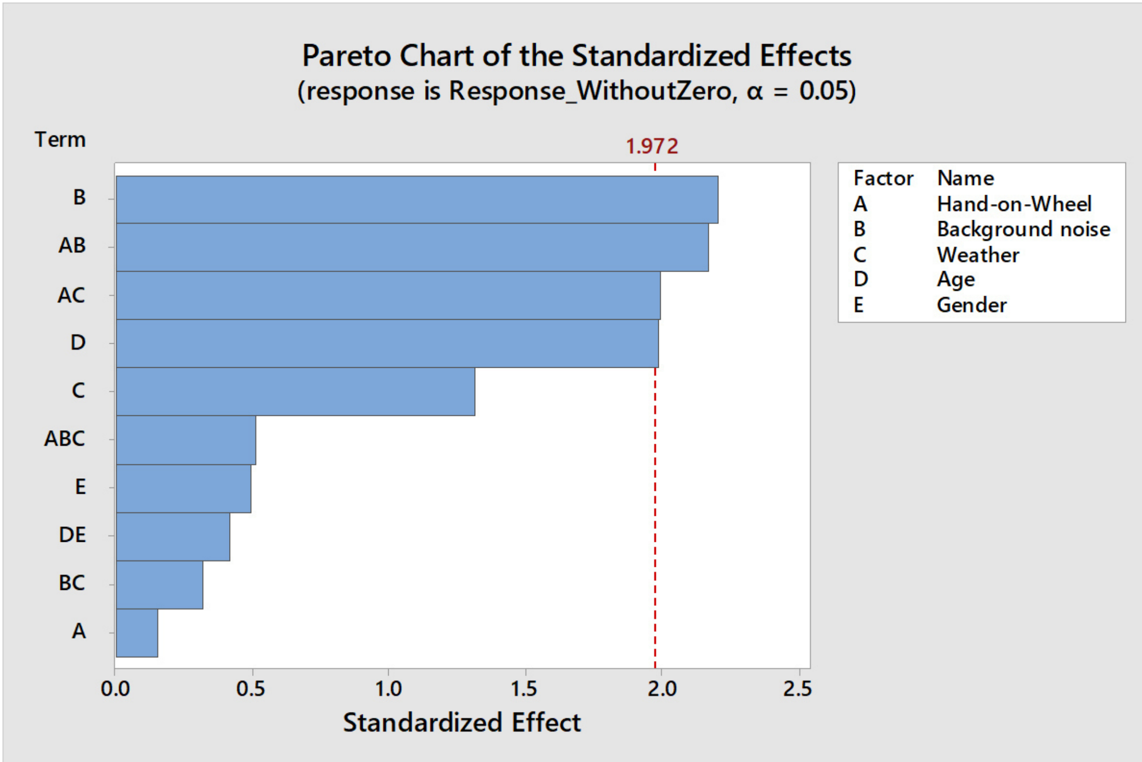

Figure 19: Pareto chart of the experiment with modified responses [created with Minitab]

Again, it shows that the Background-Noise is the most important factor influencing driving performance followed by interaction between Background-Noise and Hand-On-Wheel, and the interaction between Hand-On-Wheel and the Weather. The ANOVA shows the following p-values for main and interaction factors (see Table 16).

Table 16: ANOVA Table of the Experiment with modified responses [created with Minitab]

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Hand-On-Wheel	1	86	86.5	0.02	0.876
Background-Noise	2	25728	12864.2	3.61	0.029
Weather	1	6170	6169.7	1.73	0.190
Age	1	14081	14081.2	3.95	0.048
Gender	1	868	868.0	0.24	0.622
Hand-On-Wheel* Background-Noise	2	25064	12532.0	3.51	0.032
Hand-On-Wheel*Weather	1	14104	14103.8	3.96	0.048
Background-Noise*Weather	2	2073	1036.3	0.29	0.748
Age*Gender	1	621	621.5	0.17	0.677
Hand-On-Wheel*Background-Noise*Weather	2	3563	1781.7	0.50	0.608
Error	191	681026	3565.6		
Lack-of-Fit	33	134151	4065.2	1.17	0.254
Pure Error	158	546875	3461.2		
Total	205	774313			

The ANOVA table shows that Background-Noise has the highest significance for responses, with a p-value of 0.029, but also the interaction between Hand-On-Wheel and Background-Noise (p-value=0.032) and the interaction between Hand-On-Wheel and Weather (p-value=0.048) are statistically significant. In addition, the Age blocking is statistically significant with p-value=0.048.

However, the intensity with which the main factors and interactions relate depends on the level of input factors. The Coefficient Table can be used to more accurately analyze which levels of significant factors have the greatest influence (see Table 17).

Table 17: Coefficient table of the experiment with modified responses [created with Minitab]

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	87.30	4.20	20.80	0.000	
Hand-On-Wheel					
One-Hand	-0.65	4.17	-0.16	0.876	1.00
Two-Hands	0.65	4.17	0.16	0.876	*
Background-Noise					
Music	15.81	5.89	2.68	0.008	1.34
News	-7.43	5.93	-1.25	0.211	1.35
Silent	-8.38	5.89	-1.42	0.156	*
Weather					
Rain	-5.49	4.17	-1.32	0.190	1.01
Snow	5.49	4.17	1.32	0.190	*
Age					
over 40	8.36	4.21	1.99	0.048	1.01
under 40	-8.36	4.21	-1.99	0.048	*
Gender					
Female	-2.07	4.20	-0.49	0.622	1.01
Male	2.07	4.20	0.49	0.622	*
Hand-On-Wheel*Background-Noise					
One-Hand Music	4.55	5.89	0.77	0.441	1.34
One-Hand News	-15.32	5.94	-2.58	0.011	1.35
One-Hand Silent	10.77	5.90	1.83	0.069	*
Two-Hands Music	-4.55	5.89	-0.77	0.441	*
Two-Hands News	15.32	5.94	2.58	0.011	*
Two-Hands Silent	-10.77	5.90	-1.83	0.069	*
Hand-On-Wheel*Weather					
One-Hand Rain	-8.29	4.17	-1.99	0.048	1.00
One-Hand Snow	8.29	4.17	1.99	0.048	*
Two-Hands Rain	8.29	4.17	1.99	0.048	*
Two-Hands Snow	-8.29	4.17	-1.99	0.048	*
Background-Noise*Weather					
Music Rain	-2.96	5.88	-0.50	0.615	1.34

Music Snow	2.96	5.88	0.50	0.615	*
News Rain	-1.43	5.93	-0.24	0.809	1.35
News Snow	1.43	5.93	0.24	0.809	*
Silent Rain	4.40	5.89	0.75	0.456	*
Silent Snow	-4.40	5.89	-0.75	0.456	*
Age*Gender					
over 40 Female	-1.76	4.20	-0.42	0.677	1.02
over 40 Male	1.76	4.20	0.42	0.677	*
under 40 Female	1.76	4.20	0.42	0.677	*
under 40 Male	-1.76	4.20	-0.42	0.677	*
Hand-On-Wheel*Background-Noise*Weather					
One-Hand Music Rain	-5.68	5.89	-0.96	0.336	1.34
One-Hand Music Snow	5.68	5.89	0.96	0.336	*
One-Hand News Rain	1.51	5.92	0.25	0.799	1.35
One-Hand News Snow	-1.51	5.92	-0.25	0.799	*
One-Hand Silent Rain	4.17	5.89	0.71	0.480	*
One-Hand Silent Snow	-4.17	5.89	-0.71	0.480	*
Two-Hands Music Rain	5.68	5.89	0.96	0.336	*
Two-Hands Music Snow	-5.68	5.89	-0.96	0.336	*
Two-Hands News Rain	-1.51	5.92	-0.25	0.799	*
Two-Hands News Snow	1.51	5.92	0.25	0.799	*
Two-Hands Silent Rain	-4.17	5.89	-0.71	0.480	*
Two-Hands Silent Snow	4.17	5.89	0.71	0.480	*

As in the analysis with unmodified responses, the Background-Noise main factor with the level Music has the greatest significance for the responses.

Figure 20 below shows the interactions between the input factors and their levels.

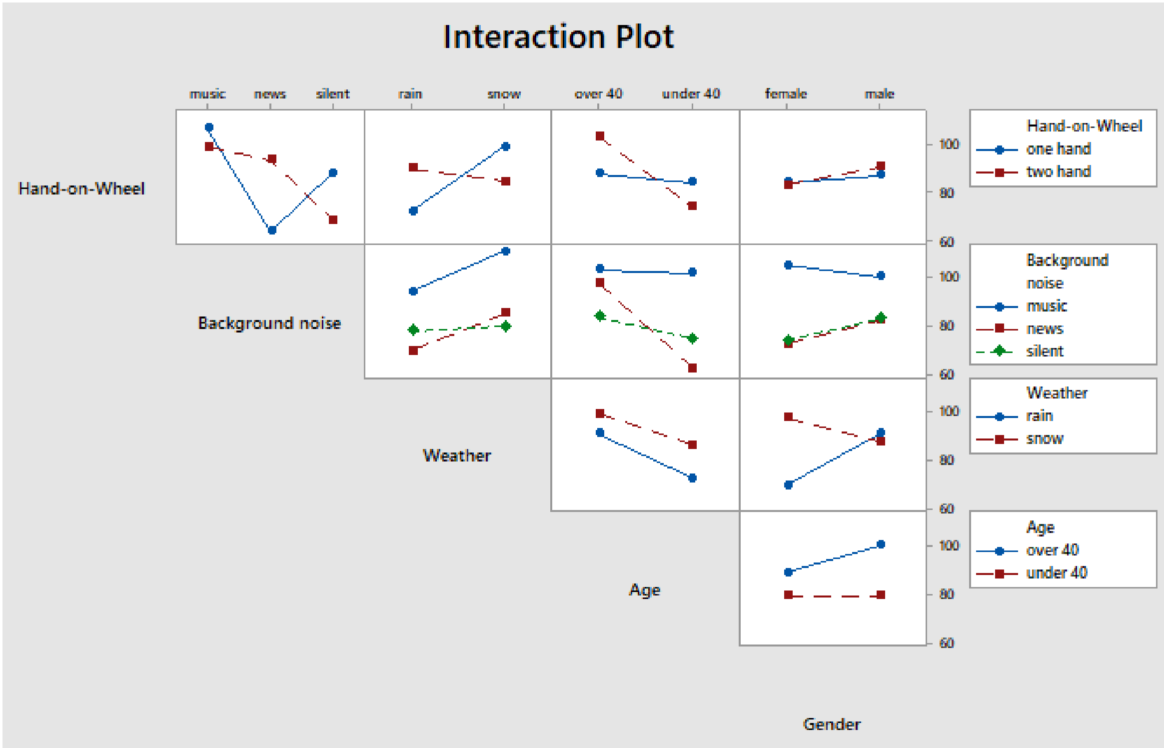

Figure 20: Interaction of the significant factors with modified responses [created with Minitab]

Figure 20 shows the interaction of all main factors and blocking factors. Based on the ANOVA table (see Table 16), only the interaction between Background-Noise and Hand-On-Wheel and between Hand-On-Wheel and Weather are significant. Figure 20 shows the interaction between the Hand-On-Wheel levels (One-Hand and Two-Hands) and Background-Noise (Music, News and silence), and Weather (Rain, Snow). Figure 20 also shows that there is a significant difference in the interaction between the Hand-On-Wheel levels and the Background-Noise levels. Driving with one hand with Background-Noise will result in a higher number of penalty points than driving with two hands without Background-Noise. The interaction between Hand-On-Wheel levels and Music as Background-Noise has the highest number of penalty points while driving of all Background-Noise levels (see Figure 20).

The evaluation of the results shows that this interaction is not statistically significant with p-value = 0.481 (see Table 16). According to Table 16, the interaction between Hand-On-Wheel and Background-Noise messages is statistically significant with a p-value = 0.016. Driving with One-Hand and Background -Noise (News) reaches a higher penalty score than driving with Two-Hand and Background-Noise (News).

The results also show that the interaction between the Hand-on-Wheel and the Weather is statistically significant. Driving with one hand and driving with Two-Hands and main factor Weather, level Rain has no significant difference in penalty points. The interaction between Hand-On-Wheel and Weather (Snow) is marginally statistically significant with the p-value =0.052. Driving with only One-Hand and main factor Weather, level Snow, however, resulted in a higher penalty score than driving with Two-Hands and main factor Weather, level Snow.

In the following sections the blocking factor Age is specifically analyzed.

4.3.2.1 Analysis of the blocking factor Age and modified responses

The ANOVA Table (Table 16) shows that the blocking factor Age is significant for an analysis with the modified answer. In this section, the responses are divided in two data sets based in the two levels of the blocking factor Age. The two data sets are under 40 and over 40. In the analysis the main factors Hand-On-Wheel (One-Hand and Two-Hands), Background-Noise (Silent, Music, News) and Weather (Snow, Rain), their combinations and the blocking factor Gender (Male, Female) are analyzed.

The Mean of the responses in the data set under 40 is 79.20 punishment points (see Table 18).

Table 18: Descriptive Statistic of the modified responses in the data set under 40 [created with Minitab]

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Responses	112	8	79.20	5.50	58.17	20.00	32.50	70.00	110.00	390.00

The descriptive statistic of the modified responses in Table 18 shows that the total number of responses for the data set under 40 is 112. The Mean of this data set is 79.20. The range is from 20 to 390 punishment points. The distributed responses of the data set Male are shown in Figure 21: Chart of modified responses for the data set under 40 [created with Minitab].

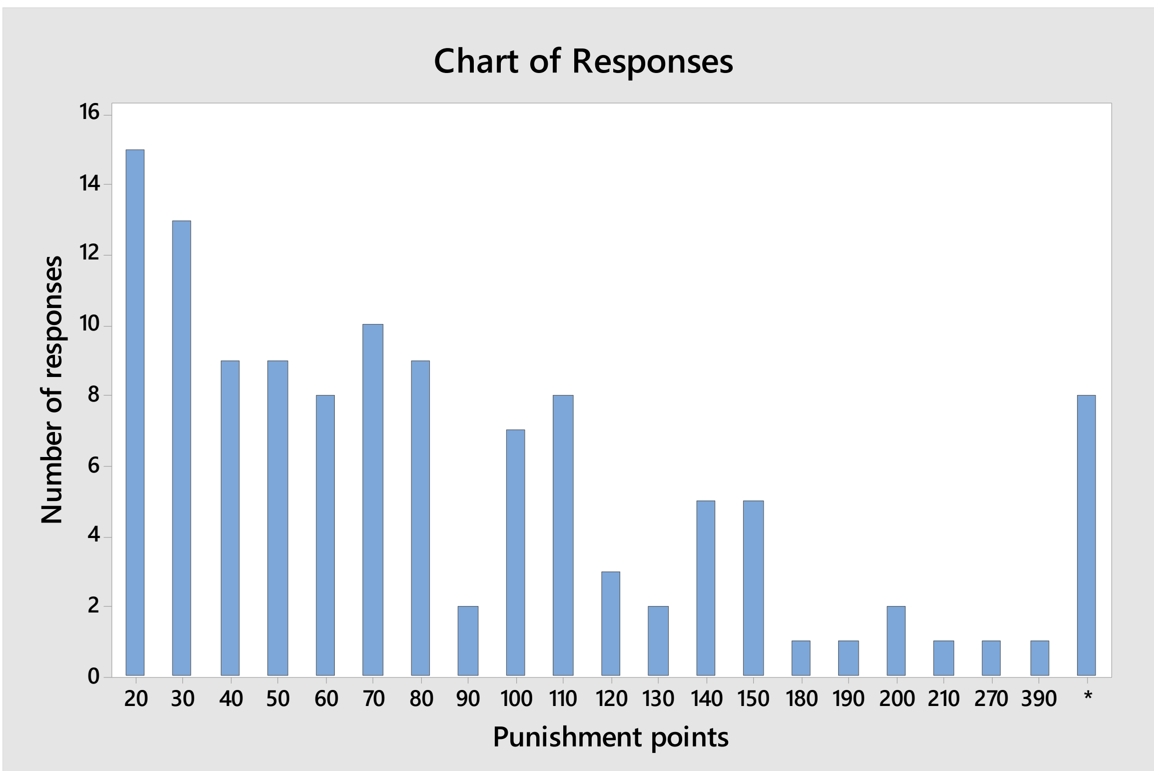

Figure 21: Chart of modified responses for the data set under 40 [created with Minitab]

The analysis of the factors can be seen in the Pareto Chart (see Figure 22).

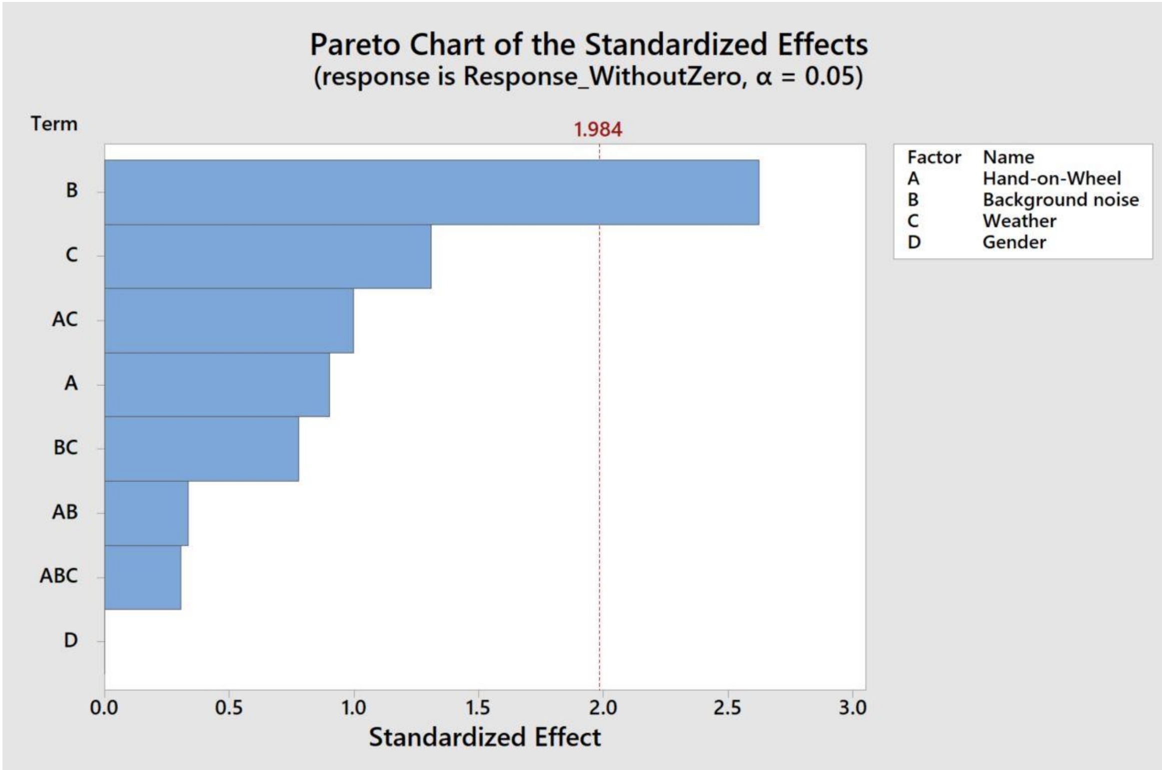

Figure 22: : Pareto chart of the data set under 40 [created with Minitab]

The Pareto Chart shows that the main factor Background-Noise is the only significant factor. The main factor Background-Noise has an p-value of 0.01 (see Table 19).

Table 19: ANOVA Table of the response of data set under 40 [created with Minitab]

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Hand-on-Wheel	1	2660	2659.5	0.81	0.370
Background noise	2	31559	15779.4	4.82	0.010
Weather	1	5621	5621.1	1.72	0.193
Hand-on-Wheel*Background noise	2	2008	1004.2	0.31	0.737
Hand-on-Wheel*Weather	1	3264	3264.1	1.00	0.320
Background noise*Weather	2	5443	2721.3	0.83	0.438
Hand-on-Wheel*Background noise*Weather	2	1809	904.6	0.28	0.759
Gender	1	0	0.0	0.00	0.999
Error	99	324061	3273.3		
Lack-of-Fit	11	67861	6169.2	2.12	0.027
Pure Error	88	256200	2911.4		
Total	111	375628			

Next, the response data set over 40 are analyzed. The Mean of this responses is 95.11 punishment points (see Table 20).

Table 20: Descriptive Statistic of the modified response in the data set over 40 [created with Minitab]

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Responses	94	26	95.11	6.64	64.40	20.00	50.00	70.00	122.50	290.00

Table 20 shows that the data set Female has a total number of 94 responses. The Mean of these responses is 95.11 and the range of this data is 20 to 290 punishment points. The distribution of the responses are shown in Figure 23.

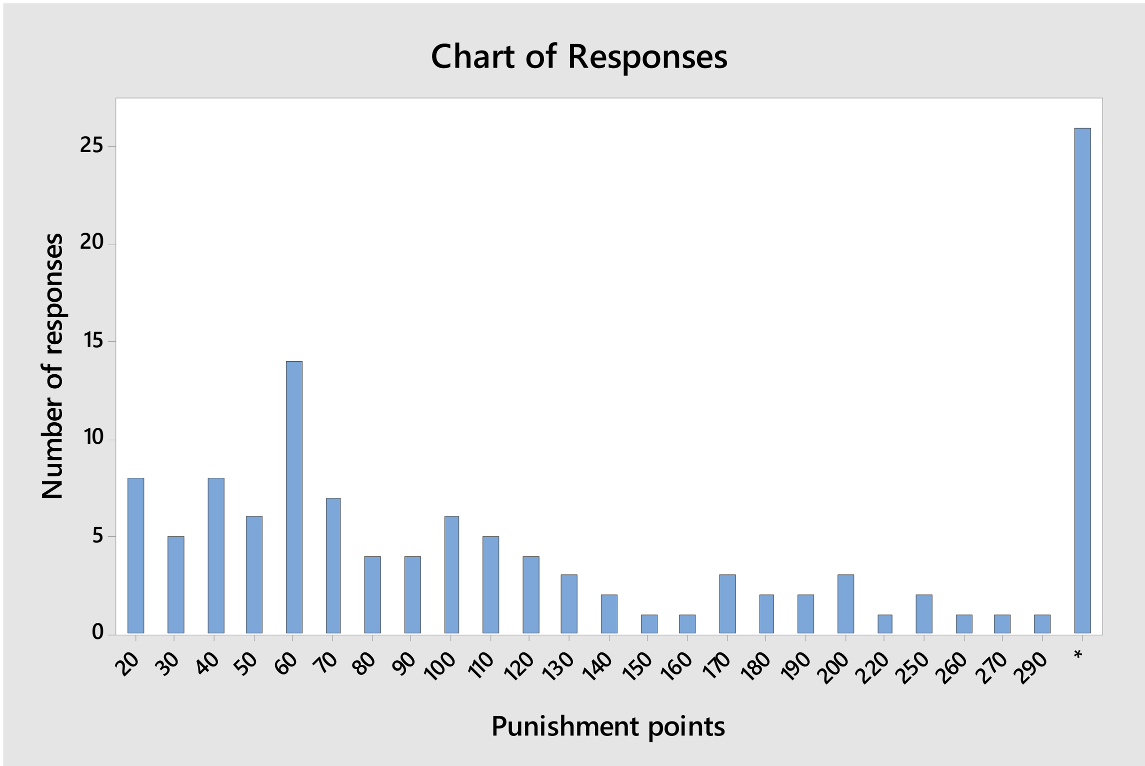

Figure 23: Chart of modified responses for the data set over 40 [created with Minitab]

The Figure 24 shows the Pareto Chart of the this analysis of this responses.

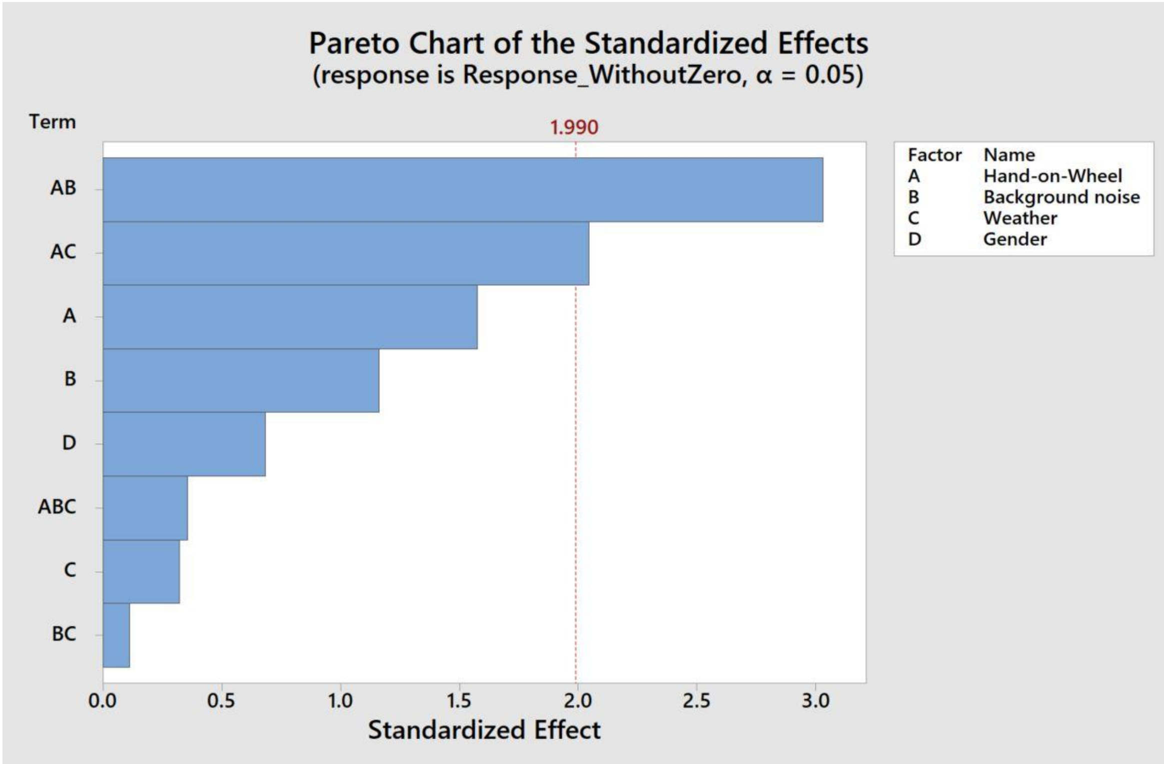

Figure 24: Pareto Chart of the data set over 40 [created with Minitab]

Based on the Pareto Chart, the main factor combination Hand-on-Wheel and Background-Noise has the most significant input on the modified responses. But the combination Hand-on-Wheel and Weather is also significant. It is also shown in the ANOVA Table of the analysis (see Table 21).

Table 21: ANOVA Table of the responses of data set over 40 [created with Minitab]

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Hand-on-Wheel	1	9394	9393.8	2.49	0.119
Background noise	2	10701	5350.7	1.42	0.248
Weather	1	391	390.8	0.10	0.749
Hand-on-Wheel*Background noise	2	46419	23209.3	6.15	0.003
Hand-on-Wheel*Weather	1	15832	15831.7	4.19	0.044
Background noise*Weather	2	719	359.5	0.10	0.909
Hand-on-Wheel*Background noise*Weather	2	2473	1236.5	0.33	0.722
Gender	1	1767	1766.6	0.47	0.496
Error	81	305905	3776.6		
Lack-of-Fit	11	15230	1384.6	0.33	0.975
Pure Error	70	290675	4152.5		
Total	93	385749			

The combination Hand-on-Wheel and Background-Noise has an p-value of 0.003 and is the most significant input on the result. The combination Hand-on-Wheel and Weather has the p-value of 0.044.

5 Discussion and Conclusion

This study aims to investigate and explore which factors could influence driving behavior. Therefore, it considers the three main factors Hand-On-Wheel (One-Hand, Two-Hands), Background-Noise (Silent, News, Music) and Weather (Rain, Snow) and examines them. The question of how these main factors and their interactions have statistically significant effects on driving behavior was examined in this thesis.

5.1 The participants of the experiment

At the beginning of the experiment, all participants first had to make statements about their driving behavior in a survey. A total of 57 subjects, 28 women, 29 men, took part in the survey. Among them are 22 participants in the age group over 40 (41-90 years) and 35 participants in the age group under 40 (18-40 years). They then drive in the same scenario in the driving simulator under different circumstances. The three main factors of the test resulted in 12 combinations, which had to be driven by the participants one after the other. During the test runs of the experiment, it was found that some participants needed up to two minutes to drive their cars normally. For this reason, the duration of each repetition was set at four minutes to make the participants feel more at ease. This decision for the long driving time posed a problem. Because of the 12 repetitions, participants had to spend at least 48 minutes in the driving simulator to complete all repetitions. This time caused many participants to suffer from motion sickness, which caused them to interrupt the attempt or even stop it altogether. Of the 57 people who started the experiment, only 20 completed all 12 repetitions. Therefore, only 35% of the participants finished driving with the driving simulator. For the analysis, it should be 5 participants of all blocking groups Male: under 40, Male: over 40 and Female: under 40, Female: over 40. The blocking factor groups: under 40 were earlier finished. This is the reason for the unequal number of participants under 40 and over 40 because after this point, mainly participants over 40 were recruited. Participants were advised to eat beforehand and they had to make a number of obligatory breaks between the repetitions while the driving simulator experiment was conducted. In addition, the participants were given water with lemon juice during the experiment to possibly relieve the symptoms. Based on the experience of the researcher, lemon water helps against seasickness and the symptoms of motion sickness are pretty similar to seasickness. It could not be clarified whether certain factors, such as the age of the participants, had a significant influence on these symptoms. However, the time of the runs should be shortened if the experiment is to be repeated.

5.2 Assessment of driving performance

Each trip of the participants was automatically regarded by the simulator with a driving assessment which summarizes all violations committed by the participant during the ride. The simulator assigns a score to the violations and evaluates the ride with a driving performance score. The evaluation of many offenses by the driving simulator did not seem appropriate. For example, High Speed Collision was rated by the simulator with a deduction of 5% in the Vehicle Handling Safety category (see Figure 20). The same number of points would also be deducted for Maximum Speed Limit Exceeded (see Figure 20). Based on the consequences of both offenses for the driver and road safety, this evaluation does not seem appropriate at all. For this reason, the evaluation technique of the percentage in Vehicle Handling Safety and Miscellaneous (see Appendix B) was not used as a starting variable for the experiment in this thesis. Instead, the driving behavior was evaluated with a different technique. The technique is based on the Rhode Island Traffic Laws. Based on the penalty for violating the law, the violations will be assessed with penalty points. The sum of the punishment points gives the new power factor and thus the rating of the driving performance. However, the problem with this evaluation technique is the statutory penalty level from which the penalty points are interpreted. Since no exact penalty for the violation has been determined in the law, the weighting of the violation with punishment points has been determined by the researcher. The evaluation of the violations with punishment points by another person can be quite different. If the experiment is repeated, an evaluation technique with less scope should be chosen.

Another problem with the chosen evaluation technique is that it is still based on the driving assessment protocol, which the driving simulator creates after each ride. However, the simulator considers, for example, a behavior such as driving too slowly, not as a violation. In addition, the assumption that the assessment of the simulator records all violations may not be correct. This is based on the observation of the researcher during the test with the driving simulator. For example, it could be observed that if two violations took place simultaneously, only one was recorded in the driving assessment protocol. This could be observed for example with the violations Maximum Speed Limit Exceeded and Following too close. For this reason, participants were possibly rated better than they actually drove. Possibly the recording of the violations and the subsequent evaluation of the driving behavior with two observers is more reliable in order to determine the output factor.

5.3 Two approaches for the analysis of the responses

The analysis of the responses from the driving simulator experiment has been performed in two ways. In the first analysis (see section 4.3.1), the experiment is performed with the main factor Hand-On-Wheel (One-Hand, Two-Hand), Background-Noise (Silent, Music, News) and Weather (Rain, Snow). The blocking factors are Gender (Male, Female) and Age (over 40, under 40). The responses variable for the first analysis is the driving performance determined by the evaluation technique (see section 4.3.1).

Therefore, the study conducted a second analysis to perform with the same main factors and blocking factors as the first analysis. The difference from the first analysis is the response variable. All zero responses are not considered in the analysis. The decision for this step has two reasons. As previously mentioned, it is possible that the driving simulator does not recognize or evaluate every violation as such (see section 5.2). In addition, participants were observed by the researcher to be extremely cautious about paying more attention to driving than would has been expected under normal circumstances. In a personal conversation after the experiment, a few participants told the researcher that they saw the driving in the driving simulator as a challenge and tried to achieve a perfect driving performance score. Other participants, according to the researcher's observations, seemed to be somewhat overwhelmed by driving in the driving simulator and often drove far below the respective speed limit during the experiment. However, this described behavior of the participants does not correspond to normal driving behavior. For these reasons, these responses with zero punishment points were not taken into account in the second analysis (see section 4.3.2).

5.3.1 Results of the analysis: main factors

Both analyses came to the conclusion that Background-Noise was the most important factor in both approaches (see Figure 14 and Figure 19). But also the combinations of the main factors Hand-On-Wheel and Background-Noise, and Hand-On-Wheel and Weather were significant factors in the second approach. This study found in the first approach that the blocking factor Gender (p-value=0.077) is approximately significant for the responses and the second approach shows the blocking factor Age (p-value=0.048) is a significant factor for the responses.

The particular importance of Background-Noise for driving behavior is also confirmed in other tests. The acoustic distraction (see section 2.2.2) can prevent the driver from driving. The experiments [38] [39] investigated the driving behavior of drivers who listened to Background-Noise. The experiment of the researchers Nowosielski, Trick and Toxopeus [38] showed that playing an audio book in an uneventful driving environment improves driving performance. As soon as the situation became more complex, for example, due to traffic signs or other cars, the driving performance decreased.

The researchers Desmet and Diependaele [39] made an experiment about acoustic distracted driving and found out, the driver concentrates less on traffic-related information while he is busy listening and this increase the risk of not perceiving changes on the road directly. This was partially confirmed by experiment with the driving simulator in this thesis.

Contrary to the expectations, the level Music of the main factor Background-Noise leads to a worse driving performance than the level News. The higher amount of information in News suggests that the driving performance should be worse here. The reason could be the choice of the participants and the choice of the played news during the experiment. At first, the played news was only political contributions. This kind of news requires some interest. Perhaps it was easy for participants who were less interested in politics or daily news to suppress the background noise. In addition, the played news was presented exclusively in English. But not all participants were native English speakers. For this reason, it may have been easier for the participant to ignore what they had heard. The played music, on the other hand, was songs that were regularly on the radio at the time of the experiment and was therefore familiar to most of the participants. For a repetition of the experiment, it could be better to choose a neutral background noise, besides music, with a topic of general interest. Also, it would have been better to play this background noise in the native language of the current driving participant.

5.3.2 Results of the analysis: combination of main factors

As described above, in the second approach the combinations of the main factors Hand-On-Wheel and Background-Noise and Hand-On-Wheel and Weather were also significant factors. The experiment of the researcher Desmet and Diependaele [39] (see section 2.2.2) examines in addition the effects of Background-Noise on eye movement during driving and the impact of hands-free calling device in the vehicle. They concluded that the driving performance is much worse, when the driver is with the acoustical distraction and still holding the phone in his hand. Also, an experiment about distracted drivers with smartphones at the Highway Safety Research Center at the University of North Carolina [56] came to the conclusion that concentrating on a secondary activity already leads to a significant increase in the risk of an accident. As described above, the Background-Noise main factor is on itself a significant response factor. The decreasing concentration on the road means that dangers on the road are detected later. If the reaction time is already shortened by the reduced focus on the road, it is understandable that the driving performance decreases further if the driver is additionally manual distracted with holding a cup or something else in their hand and therefore cannot steer the car properly. Driving with only one hand reduces the driver's control over the steering wheel and thus over the vehicle, especially in sudden danger situations. This fact could be proved with the driving simulations experiment because the second approach shows that the combination of the main factors Hand-On-Wheel and Background-Noise is significant for the driving performance.

In these environments, the additional distraction led to a further deterioration in driving performance. The second approach shows that the combination of the main factors Hand-On-Wheel and Weather is also significant for the driving performance. As already described, the driver is manual distracted when he is holding a cup during driving. In addition, the driver’s ability to drive the vehicle becomes more difficult to maintain control if the vehicle reacts unpredictably. The weather conditions, especially black ice on the roads like in the driving simulator experiment, can lead to this. Since the vehicle's behavior is not always predictable it therefore explains why this factor is significant. The research of Nofal and Saeed [67] underline this conclusion. They found out that the seasonal weather influences the number and types of road traffic accidents over the year.

5.3.3 Results of the analysis: blocking factors

The first and second approaches showed that the blocking factors could presumably have a significant impact on the responses, too.

The first approach of the analysis suggests the conclusion that the blocking factor Gender (p-value=0.077) could be approximately significant for the responses. Therefore, this study is interested to conduct the different impact between gender based on the main and interaction factors. For these analyses of the blocking factors, the unmodified responses of the first approach are divided into two data sets Male and Female. The two data sets are analyzed separately (see 4.3.1.1).

The analysis shows that for the data set Male no factor was significant. The reason being that the responses of the data set Male does not have high variations among the male participant's responses; which resulted in the descriptive analysis that demonstrated that the mean is 66.92 while the standard deviation is 66.04 (see Table 12).

For the data set Female, this study found that only the main factor Weather is significant. Other studies identified the weather as a significant factor for the driving performance. Hoogendoorn, Tamminga, Hoogendoorn and Daamen [66] declared that the driving behavior, under adverse weather conditions for unfavorable weather conditions, have a considerable influence on the flow of traffic. The researchers Nofal and Saeed [67] showed in their paper that there are seasonal weather fluctuations influencing the number and types of road traffic accidents over the year. For example, in the summer seasons, more accidents are triggered by heavy traffic but also by intense sunlight. But, no other research with public access could be found that would underline the result of the analysis that snowy and rainy weather conditions have a higher impact on the driving performance of women than men. This has to be verified in a following experiment. The study by Laapotti and Keskinen (1998) investigated fatal control loss accidents in young male and female drivers surveyed by the Road Accident Investigation Team in Finland [68]. The results showed that in male drivers, control loss accidents were often due to speeding or alcohol influence. Typically, male drivers lost control resulting in accidents in the evening and at night. On the other hand, control loss accidents among female drivers usually occurred in slippery road conditions [68]. This supports the results of this thesis that the weather is a significant factor for the driving performance of female drivers. However, the study only examined drivers between the ages of 18 and 21. In addition, 338 men and 75 women were examined in accidents [68].

The comparison of the Means of both data sets show that the Mean of the female participants is 66.92 and 81.50 for male participants. This suggests the conclusion that the female participants drove better because they reached in average a lower number of punishment points. But the descriptive analysis of both data sets also shows that the male drivers reached 290 maximum. The female drivers with the lowest driving performance has 390 punishment points, even though this number can only be traced back to one participant (see Figure 17).

The results of the paper “Traffic Accident involvement rates by driver age and gender” of Massie, Campbell and Williams verified that men had a higher risk than women of experiencing a crash [69]. But the study also recognized that a driver’s performance depends on the age of the drivers. It was recognized that older drivers had a higher fatal accident rate, while mainly young and unexperienced drivers had a high rate of involvement in crashes reported by police [69]. The mean of blocking factor groups is male under 40: 77.83, male over 40: 85.17, female under 40: 70 and female over 40: 63.83. The comparison shows that females over 40 have the lowest Mean of punishment points which mean they have the best driving performance. The study of Borowsky, Shinar and Oron-Gilad (2010) came to similar results and argue that older drivers are more experience in the driving process [70]. These results are conflicted with the results of the study of Allen, Beck and Zanjani (2019) which came to the conclusion that age has a negative impact on the driving performance [73]. These results should be investigated in following studies.

Through an analysis, the significant factors on the driving performance of men and women, which vary according to age, have been determined. However, the results are not entirely reliable due to the limited number of replications performed per data set. There are 120 replications in each data set compared to 240 replications for the analysis with the undivided responses. The previous studies emphasize that the number of replications could influence and reduce the variability such as the publication "Design issues for cDNA microarray experiments of Y. H. Yang and T. Speed [68]. Therefore, the results of the experiment may be sensitive in terms of the number of replications.

The second approach shows that the blocking factor Age (p-value=0.048) is a significant factor for the responses. The modified responses of the second approach are divided into the data sets under 40 and over 40 and then analyzed separately (see section 4.3.2.1). The analysis shows that for the data set under 40, the main factor Background-Noise is significant. For the data set over 40, the combination of the main factors Hand-On-Wheel and Background-Noise and Hand-On-Wheel and Weather are significant. Therefore, results of the analysis demonstrate that the main factor Background-Noise has a significant influence for both drivers' age groups (under 40 and over 40). But the experiment results for the drivers over 40 years show that combinations of the main factors have a significant influence on driving performance. These study findings validate that the Age is a significant factor. Based on the limited number of replications performed per data set, the results need to be verified with other sources and results.

The mean of the responses in the data set under 40 is 79.20 (see Table 18) and the mean of the responses in the data set over 40 (see Table 20) is 95.11. This mean of the responses of the data set under 40 is 15.91 lower than over 40, which means the participants in this group had a better driving performance.

The researchers Rhodes and Pivik [71] conducted a survey in the US state of Alabama to investigate the relationship between risk perception and risky driving. They came to the conclusion that risky behavior is more likely to occur in younger drivers. Other studies also suggest this conclusion. In contrast, researcher of the paper “Vision, Aging, and Driving: The Problems of Older Drivers” [72] interviewed participants aged 22-92 about their visual impairments while driving and about performing everyday tasks. Many of the respondents in the higher ages indicated that unexpected vehicles, vehicle speed, dim displays, windshield problems, and sign reading caused them problems from time to time [72]. These problems also seemed to be related to the more frequent car accidents among older drivers. But besides the age-related changes in visual function, the aging population also has other factors which have an impact on safe driving. A study by Allen, Beck and Zanjani (2019) investigated the driving concerns of older adults and their ability to drive [73]. They found that eighty-four percent of participants reported at least one driving problem. The most commonly reported driving problems were other drivers in general, driving at night, vision and awareness, and aggressive or reckless drivers.

5.4 Limitations of the study

In addition, this study acknowledges some limitations. These limitations could impact the reliabilities of the findings. Therefore, the limitations could be classified as the following: First, this study had a challenge to recruit in order to have enough of a homogenous sample size. Because of the length of the study, a lot of people did not want to participate or did not show up. Also, the motion sickness held some people back.

Second, the software Scenario Builder™ is limited to create experiments that identify which factor could impact the driving performance. Hence, the simulator had less sensitives to record all the drivers' violations during the experiment. Especially, the simulator had less flexibility to design the experiment scenario. For example, it was only possible to place a limited number of cars and pedestrians.

Based on the descriptive analysis, the standard deviation is larger than the mean and that can also impact the factors. Therefore, the significant factors of main and interaction factors are sensitive to the standard deviation of the responses.

Finally, the traffic policies vary from state to state, which could intern make it difficult to use our study's approach to compute the driving performance based on the punishment scoring.

6 Summary and Future Work

In this thesis, an attempt has been made to investigate the effects of distracted driving on driving performance. In the experiment, the participants first took part in a survey about their driving behavior. Then they drove in the driving simulator. During this process, the main factors Hand-On-Wheel, Background-Noise and Weather with their interactions were analyzed. The three main factors of the test resulted in 12 combinations, which had to be driven by the participants one after the other. With the response of the repetitions, this thesis explores the magnitude of the negative effects of these distraction factors and their combinations.

The results of the analysis in the thesis concludes that the most significant factor for the driving performance is the Background-Noise. The analysis of the modified responses shows that the interaction between Hand-On-Wheel and Background-Noise and between Hand-On-Wheel and the Weather are also significant. Based on the analysis of the blocking factors, the background noise is an important aspect for the driving performance of people over and under 40. For people under 40, the background noise in general has a negative impact. Whereas for people over 40, the combination Hand-On-Wheel and Background-Noise and the combination Hand-On-Wheel and Weather have a significant impact for driving performance. The analysis of the blocking factor Gender with the unmodified responses shows that the main factor Weather is significant for the driving performance for women. For men, there was no significant factor. But both results of the analysis about Gender could not be verified.

In summary, the analysis results of the experiment proved that even seemingly insignificant distractions influence the driver's attention so that driving performance decreases. Even if some of the main factors did not affect driving performance alone, all of the main factors, which were investigated, analyzed in combination with another main factor had a negative effect on driving performance.

The ever-increasing number of cars and the fact that most people spend more and more time in the car is expected to increase the number of fatalities due to distractions while driving. To counteract this number, more education is needed to make drivers and passengers more aware of this problem. In the survey, which was also conducted as part of this work, 89.47% of participants, regardless of Age or Gender, stated that they listen to music or the radio and 92.98% of the participants said that they sometimes drive with only one hand. From the research point of view, it makes sense to further investigate the effect and impact of distracted driving.

For future studies, the analysis of the blocking factors Age (under 40, over 40) and Gender (Male, Female) are recommended with more specification to determine which of the main factors are significant for the responses and to verify the results. Therefore, this study recommends analyzing and comparing these findings with actual traffic reports of accidents based on gender and age. In addition, this study suggests for future research to use blocking factors such as, types of drivers licenses (for example, learner’s permit and commercial driver’s license), drivers’ medical history (for example, memory and vision), and drivers’ accident history (for example, no accident or accident record).

This study recommends to include and investigate more factors that could have an impact on the driving performance main factor levels and their combinations, such as speed limit (for example, above traffic speed limit, and below or equal traffic speed limit), daylight (for example, morning and night) and road types (for example, highway and side roads). Also, for the Background-Noise level Music and News use for each participant the same audio record for both levels to control the emotional factor of the participant. Then, a study with a larger and homogenous sample number size is suggested and recommended to represent the population in a certain country or state.

Appendix A

THE UNIVERSITY OF RHODE ISLAND

IRB Exempt Consent

Tobias Bopp
Department of Industrial and Systems Engineering
Analyzing the Correlations among Driver Distractions and the Probability of an Accidents

You will be asked to participate in a research study. The purpose of the research study is to analyze the relationship between driver distractions and the probability of an accident. Please read the following points before deciding to participate in the study. First, you will participate in a survey conducted with SurveyMonkey that will take approximately 5 minutes to complete. In this survey you will be asked general questions about your driving behavior and yourself. You will then take part in an experiment with a driving simulator. In the course of this experiment you will perform a scenario on the simulator under various conditions. This will take about 30 to 60 minutes, depending on whether you are between the runs. For participation in the experiment are no known risks, benefits or compensation.

Your responses will be strictly anonymous. The responses may be used for research at the University of Rhode Island.

The decision to participate in this experiment is entirely up to you. You may refuse to take part in the study at any time without affecting your relationship with the investigators of this study or the University of Rhode Island (URI). Your decision will not result in any loss of benefits to which you are otherwise entitled. You have the right not to answer any single question, as well as to withdraw completely from the experiment at any point during the process; additionally, you have the right to request that the researchers not use any of your responses.

You have the right to ask questions about this research study and to have those questions answered by me before, during or after the research. If you have questions about the study, at any time feel free to contact Jyh-Hone Wang from the Department of Industrial and Systems Engineering, at 401.874.5195.

Additionally, you may contact the URI Institutional Review Board (IRB) if you have questions regarding your rights as a research participant. Also contact the IRB if you have questions, complaints or concerns which you do not feel you can discuss with the investigator. The University of Rhode Island IRB may be reached by phone at (401) 874-4328 or by e-mail at researchintegrity@etal.uri.edu. You may also contact the URI Vice President for Research and Economic Development by phone at (401) 874-4576.

If you want to have a copy of this, please ask the researcher.

By confirming that you have read this consent form, you also confirm that you are ready to participate in this study and that you understand and accept the following terms and conditions.
By confirming that you have read this consent form, you indicate that you have read and understood the above and volunteer to participate in this experiment.

I understand

button in the online survey

UNIVERSITY OF
Rhode Island

Analyzing the Correlations among Driver Distractions and the Probability of an Accidents Questionnaire

Please indicate your:

— **Age:** ☐ Under 40 ☐ Over 40

— **Gender:** ☐ Female ☐ Male

1. **How many years have you had your driver's license?**

☐ 1-5 years ☐ 6 - 10 years ☐ over 10 years

2. **How often do you drive?**

☐ More than once a day ☐ Once a day ☐ Twice a week ☐ Thrice a week
☐ Once a week ☐ Twice a month ☐ Once a month ☐ Other

3. **How much time do you spend driving an average per day?**

☐ Less than 30 minutes ☐ 30 - 60 minutes ☐ 1 - 2 hour ☐ 2 - 4 hours
☐ more than 4 hours

4. **Are you aware of behavior that distract you from driving?**

☐ Yes ☐ No

5. **Do you sometimes only have one hand on the steering wheel while driving?**

☐ Yes ☐ No

6. **Do you mostly listen to music or radio while driving a car?**

☐ Yes ☐ No

7. **Are you aware that distracted driving increases the likelihood of an accident?**

☐ Yes ☐ No

Appendix B

Driver Assessment

Driver Name:	Participant 003	Scenario:	_MASTERTHESIS_TOBIAS12
Driver ID:	00000000003	Vehicle:	CAR_FORD_TAURUS_WHITE
Date:	4/20/2019 11:55:01AM	Passed:	True
Average MPG:	4.05	Violations:	12
Distance:	1.01	Warnings:	0
Scenario Time:	4:00	Score:	60.00

Miscellaneous — 100%

No Violations	0.00

Vehicle Handling Safety — 60%

00:17 - Medium Speed Collision; Other Vehicle Speed =32	5.00
01:21 - Hard braking; Initial speed = 28.87 MPH	3.00
01:29 - Following too close; lead time=4 speed= 33 vehicle 54 Medium Snow	3.00
01:32 - Hard braking; Initial speed = 31.65 MPH	3.00
01:57 - Following too close; lead time=4 speed= 23 vehicle 91 Medium Snow	3.00
02:12 - Following too close; lead time=5 speed= 31 vehicle 91 Medium Snow	3.00
02:23 - Following too close; lead time=4 speed= 39 vehicle 91 Medium Snow	3.00
02:27 - Hard braking; Initial speed = 34.05 MPH	3.00
02:51 - Hard braking; Initial speed = 27.10 MPH	3.00
03:10 - Hard braking; Initial speed = 40.94 MPH	3.00
03:22 - Hard braking; Initial speed = 32.48 MPH	3.00
03:47 - Medium Speed Collision; Other Vehicle Speed =25	5.00

Appendix C

Participants:	Hand-on-Wheel:	Back-ground-Noise:	Weather:	Comment:	Violation of the Driving Assessment
18-40 years, male, Participant 1	Two hands	Silent	Rain		00:25 - Following too close; lead time=1 speed= 35 vehicle 134 Medium Rain 3.00 01:47 - Following too close; lead time=4 speed= 36 vehicle 119 Medium Rain 3.00 01:56 - Following too close; lead time=4 speed= 22 vehicle 119 Medium Rain 3.00 03:28 - Following too close; lead time=2 speed= 23 vehicle 155 Medium Rain 3.00
	One hand	Music	Snow		01:02 - Following too close; lead time=4 speed= 31 vehicle 197 Medium Snow 3.00
	Two hands	News	Rain		00:43 - Following too close; lead time=3 speed= 21 vehicle 123 Medium Rain 3.00
	Two hands	Music	Rain		00:48 - Following too close; lead time=4 speed= 17 vehicle 123 Medium Rain 3.00 01:24 - Following too close; lead time=3 speed= 14 vehicle 191 Medium Rain 3.00 02:21 - Following too close; lead time=3 speed= 26 vehicle 91 Medium Rain 3.00
	Two hands	Silent	Snow		00:58 - Following too close; lead time=4 speed= 26 vehicle 197 Medium Snow 3.00 01:29 - Following too close; lead time=4 speed= 27 vehicle 197 Medium Snow 3.00
	One hand	News	Snow		01:35 - Following too close; lead time=5 speed= 28 vehicle 54 Medium Snow 3.00 02:13 - Following too close; lead time=5 speed= 34 vehicle 54 Medium Snow 3.00 02:23 - Following too close; lead time=5 speed= 17 vehicle 180 Medium Snow 3.00
	One hand	Music	Rain		00:33 - Following too close; lead time=2 speed= 19 vehicle 58 Medium Rain 3.00 01:17 - Following too close; lead time=3 speed= 23 vehicle 75 Medium Rain 3.00 03:13 - Following too close; lead time=4 speed= 35 vehicle 98 Medium Rain 3.00
	One hand	Silent	Rain		01:28 - Following too close; lead time=2 speed= 27 vehicle 113 Medium Rain 3.00
	Two hands	News	Snow		01:15 - Following too close; lead time=4 speed= 22 vehicle 130 Medium Snow 3.00 01:56 - Following too close; lead time=4 speed= 18 vehicle 109 Medium Snow 3.00 02:19 - Following too close; lead time=1 speed= 23 vehicle 187 Medium Snow 3.00 03:18 - Following too close; lead time=4 speed= 20 vehicle 189 Medium Snow 3.00
	Two hands	Music	Snow		No Violations 0.00
	One hand	Silent	Snow		01:25 - Following too close; lead time=4 speed= 30 vehicle 44 Medium Snow 3.00 02:04 - Following too close; lead time=2 speed= 24 vehicle 24 Medium Snow 3.00 02:13 - Following too close; lead time=3 speed= 27 vehicle 123 Medium Snow 3.00
	One hand	News	Rain		00:52 - Following too close; lead time=1 speed= 20 vehicle 123 Medium Rain 3.00 01:07 - Following too close; lead time=1 speed= 36 vehicle 137 Medium Rain 3.00 02:27 - Following too close; lead time=4 speed= 25 vehicle 41 Medium Rain 3.00
18-40 years, male, Participant 2	Two hands	Silent	Rain		00:47 - Following too close; lead time=3 speed= 31 vehicle 16 Medium Rain 3.00
	One hand	Music	Snow		00:52 - Following too close; lead time=5 speed= 19 vehicle 113 Medium Snow 3.00 01:05 - Following too close; lead time=2 speed= 19 vehicle 72 Medium Snow 3.00 01:45 - Hard braking; Initial speed = 32.18 MPH 3.00

	Two hands	News	Rain	00:47 - Following too close; lead time=2 speed= 27 vehicle 179 Medium Rain 3.00 02:53 - Following too close; lead time=4 speed= 43 vehicle 181 Medium Rain 3.00 03:10 - Following too close; lead time=4 speed= 29 vehicle 181 Medium Rain 3.00
	Two hands	Music	Rain	00:45 - Following too close; lead time=2 speed= 28 vehicle 123 Medium Rain 3.00 02:07 - Hard braking; Initial speed = 44.63 MPH 3.00 02:34 - Medium Speed Collision; Other Vehicle Speed =21 5.00 03:08 - Following too close; lead time=3 speed= 29 vehicle 139 Medium Rain 3.00 03:44 - Following too close; lead time=4 speed= 27 vehicle 181 Medium Rain 3.00
	Two hands	Silent	Snow	02:20 - Following too close; lead time=6 speed= 29 vehicle 60 Medium Snow 3.00
	One hand	News	Snow	00:56 - Following too close; lead time=4 speed= 18 vehicle 123 Medium Snow 3.00 02:08 - Following too close; lead time=6 speed= 36 vehicle 30 Medium Snow 3.00 02:19 - Following too close; lead time=2 speed= 42 vehicle 30 Medium Snow 3.00
	One hand	Music	Rain	00:34 - Following too close; lead time=4 speed= 27 vehicle 113 Medium Rain 3.00 00:54 - Following too close; lead time=3 speed= 7 vehicle 113 Medium Rain 3.00 02:29 - Medium Speed Collision; Other Vehicle Speed =20 5.00 03:41 - Following too close; lead time=2 speed= 22 vehicle 77 Medium Rain 3.00
	One hand	Silent	Rain	00:54 - Following too close; lead time=4 speed= 36 vehicle 99 Medium Rain 3.00 01:28 - Low Speed Collision; Speed =0 5.00 01:48 - Following too close; lead time=2 speed= 10 vehicle 53 Medium Rain 3.00
	Two hands	News	Snow	02:52 - Following too close; lead time=4 speed= 33 vehicle 175 Medium Snow 3.00 03:02 - Following too close; lead time=4 speed= 33 vehicle 175 Medium Snow 3.00
	Two hands	Music	Snow	01:02 - Following too close; lead time=4 speed= 25 vehicle 197 Medium Snow 3.00 02:11 - Following too close; lead time=4 speed= 38 vehicle 200 Medium Snow 3.00
	One hand	Silent	Snow	01:43 - Following too close; lead time=1 speed= 24 vehicle 201 Medium Snow 3.00 02:06 - Following too close; lead time=4 speed= 46 vehicle 203 Medium Snow 3.00
	One hand	News	Rain	00:56 - Following too close; lead time=3 speed= 23 vehicle 197 Medium Rain 3.00 01:21 - Following too close; lead time=5 speed= 44 vehicle 197 Medium Rain 3.00 01:31 - Following too close; lead time=2 speed= 5 vehicle 75 Medium Rain 3.00
18-40 years, male, Participant 3	Two hands	Silent	Rain	00:59 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	One hand	Music	Snow	01:49 - Following too close; lead time=3 speed= 18 vehicle 123 Medium Snow 3.00 02:54 - Following too close; lead time=2 speed= 37 vehicle 134 Medium Snow 3.00
	Two hands	News	Rain	02:13 - Following too close; lead time=4 speed= 41 vehicle 164 Medium Rain 3.0002:58 - Hard braking; Initial speed = 47.18 MPH 3.0003:07 - Following too close; lead time=3 speed= 44 vehicle 157 Medium Rain 3.0003:41 - Maximum Speed Limit Exceeded 81 should be 75 5.0003:48 - Hard braking; Initial speed = 46.14 MPH 3.00

	Two hands	Music	Rain	01:14 - Following too close; lead time=3 speed= 35 vehicle 192 Medium Rain 3.00 01:52 - Hard braking; Initial speed = 58.37 MPH 3.00 02:17 - Too fast for Medium Rain conditions: 73 should be 70 5.00 02:21 - Hard braking; Initial speed = 68.74 MPH 3.00 02:34 - Too fast for Medium Rain conditions: 71 should be 70 5.00 02:43 - Too fast for Medium Rain conditions: 74 should be 70 5.00 02:48 - Following too close; lead time=6 speed= 68 vehicle 45 Medium Rain 3.00 03:20 - Following too close; lead time=5 speed= 66 vehicle 142 Medium Rain 3.00 03:29 - Hard braking; Initial speed = 55.11 MPH 3.00
	Two hands	Silent	Snow	01:09 - Hard braking; Initial speed = 35.95 MPH 3.00 01:25 - Following too close; lead time=2 speed= 45 vehicle 186 Medium Snow 3.00 01:32 - Hard braking; Initial speed = 51.15 MPH 3.00 01:58 - Hard braking; Initial speed = 53.39 MPH 3.00 03:00 - Hard braking; Initial speed = 55.17 MPH 3.00 03:43 - Hard braking; Initial speed = 42.35 MPH 3.00
	One hand	News	Snow	01:49 - Following too close; lead time=5 speed= 55 vehicle 1 Medium Snow 3.00 01:55 - Hard braking; Initial speed = 44.10 MPH 3.00 02:56 - Hard braking; Initial speed = 49.56 MPH 3.00 03:43 - Hard braking; Initial speed = 55.57 MPH 3.00 03:52 - Following too close; lead time=5 speed= 48 vehicle 57 Medium Snow 3.00
	One hand	Music	Rain	00:23 - Following too close; lead time=2 speed= 34 vehicle 113 Medium Rain 3.00 00:51 - Following too close; lead time=1 speed= 7 vehicle 137 Medium Rain 3.00 02:12 - Hard braking; Initial speed = 54.12 MPH 3.00 02:45 - Hard braking; Initial speed = 53.48 MPH 3.00 04:01 - Hard braking; Initial speed = 40.84 MPH 3.00
	One hand	Silent	Rain	01:08 - Following too close; lead time=1 speed= 31 vehicle 137 Medium Rain 3.00 01:23 - Following too close; lead time=2 speed= 41 vehicle 166 Medium Rain 3.00 01:36 - Following too close; lead time=1 speed= 39 vehicle 140 Medium Rain 3.00 01:50 - Hard braking; Initial speed = 57.43 MPH 3.00 02:18 - Following too close; lead time=2 speed= 38 vehicle 57 Medium Rain 3.00 02:38 - Hard braking; Initial speed = 51.13 MPH 3.00 03:35 - Following too close; lead time=4 speed= 49 vehicle 199 Medium Rain 3.00 03:39 - Hard braking; Initial speed = 52.08 MPH 3.00 03:46 - Following too close; lead time=4 speed= 42 vehicle 174 Medium Rain 3.00
	Two hands	News	Snow	00:27 - Hard braking; Initial speed = 44.88 MPH 3.00 00:44 - Hard braking; Initial speed = 34.70 MPH 3.00 01:20 - Maximum Speed Limit Exceeded 78 should be 75 5.00
	Two hands	Music	Snow	00:29 - Following too close; lead time=3 speed= 31 vehicle 134 Medium Snow 3.00 00:49 - Following too close; lead time=3 speed= 27 vehicle 195 Medium Snow 3.00 01:28 - Following too close; lead time=4 speed= 31 vehicle 192 Medium Snow 3.00
	One hand	Silent	Snow	00:39 - Following too close; lead time=2 speed= 32 vehicle 156 Medium Snow 3.00 00:41 - Hard braking; Initial speed = 30.74 MPH 3.00 01:11 - Hard braking; Initial speed = 26.50 MPH 3.00
	One hand	News	Rain	00:48 - Following too close; lead time=2 speed= 23 vehicle 137 Medium Rain 3.00 01:45 - Following too close; lead time=3 speed= 28 vehicle 120 Medium Rain 3.00
18-40 years, male, Participant 4	Two hands	Silent	Rain	02:10 - Following too close; lead time=1 speed= 17 vehicle 39 Medium Rain 3.00 02:35 - Following too close; lead time=2 speed= 25 vehicle 202

				Medium Rain 3.00 03:00 - Medium Speed Collision; Other Vehicle Speed =22 5.00
	One hand	Music	Snow	No Violations 0.00
	Two hands	News	Rain	02:51 - Following too close; lead time=4 speed= 21 vehicle 18 Medium Rain 3.00 03:18 - Medium Speed Collision; Other Vehicle Speed =21 5.00
	Two hands	Music	Rain	01:07 - Low Speed Collision; Speed =9 5.00 01:43 - Following too close; lead time=3 speed= 17 vehicle 93 Medium Rain 3.00
	Two hands	Silent	Snow	01:17 - Following too close; lead time=3 speed= 20 vehicle 105 Medium Snow 3.00 02:00 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	One hand	News	Snow	00:46 - Following too close; lead time=4 speed= 21 vehicle 75 Medium Snow 3.00 01:11 - Following too close; lead time=2 speed= 29 vehicle 192 Medium Snow 3.00 01:49 - Medium Speed Collision; Speed =31 5.00
	One hand	Music	Rain	00:50 - Following too close; lead time=3 speed= 20 vehicle 93 Medium Rain 3.00 02:36 - Following too close; lead time=4 speed= 40 vehicle 53 Medium Rain 3.00 02:56 - Following too close; lead time=4 speed= 41 vehicle 53 Medium Rain 3.00
	One hand	Silent	Rain	00:50 - Following too close; lead time=3 speed= 18 vehicle 75 Medium Rain 3.0001:23 - Following too close; lead time=3 speed= 19 vehicle 192 Medium Rain 3.0001:55 - Following too close; lead time=2 speed= 22 vehicle 143 Medium Rain 3.0002:12 - Following too close; lead time=3 speed= 21 vehicle 122 Medium Rain 3.00
	Two hands	News	Snow	01:09 - Following too close; lead time=5 speed= 18 vehicle 195 Medium Snow 3.00 03:08 - Following too close; lead time=5 speed= 30 vehicle 1 Medium Snow 3.00
	Two hands	Music	Snow	01:36 - Medium Speed Collision; Other Vehicle Speed =20 5.00 02:27 - Following too close; lead time=1 speed= 18 vehicle 203 Medium Snow 3.00
	One hand	Silent	Snow	00:47 - Following too close; lead time=4 speed= 17 vehicle 114 Medium Snow 3.00 01:56 - Following too close; lead time=5 speed= 17 vehicle 30 Medium Snow 3.00 03:11 - Following too close; lead time=4 speed= 27 vehicle 2 Medium Snow 3.00
	One hand	News	Rain	02:59 - Following too close; lead time=5 speed= 37 vehicle 174 Medium Rain 3.00
18-40 years, male, Participant 5	Two hands	Silent	Rain	01:10 - Following too close; lead time=1 speed= 17 vehicle 109 Medium Rain 3.00 02:06 - Following too close; lead time=3 speed= 29 vehicle 50 Medium Rain 3.00 02:37 - Following too close; lead time=2 speed= 37 vehicle 50 Medium Rain 3.00 03:02 - Following too close; lead time=4 speed= 37 vehicle 174 Medium Rain 3.00
	One hand	Music	Snow	01:06 - Following too close; lead time=1 speed= 6 vehicle 27 Medium Snow 3.00 01:27 - Low Speed Collision; Speed =0 5.00 01:29 - Following too close; lead time=0 speed= 8 vehicle 27 Medium Snow 3.00 02:11 - Following too close; lead time=5 speed= 29 vehicle 60 Medium Snow 3.00
	Two hands	News	Rain	01:51 - Following too close; lead time=3 speed= 32 vehicle 178 Medium Rain 3.00
	Two hands	Music	Rain	01:10 - Low Speed Collision; Speed =7 5.00 01:46 - Following too close; lead time=4 speed= 19 vehicle 113 Medium Rain 3.00 02:11 - Following too close; lead time=3 speed= 32 vehicle 50 Medium Rain 3.00

	Two hands	Silent	Snow	00:46 - Following too close; lead time=3 speed= 30 vehicle 93 Medium Snow 3.00 01:16 - Following too close; lead time=4 speed= 21 vehicle 192 Medium Snow 3.00
	One hand	News	Snow	00:36 - Following too close; lead time=4 speed= 11 vehicle 58 Medium Snow 3.00 02:32 - Following too close; lead time=4 speed= 31 vehicle 91 Medium Snow 3.00 03:23 - Following too close; lead time=4 speed= 30 vehicle 157 Medium Snow 3.00 03:37 - Following too close; lead time=2 speed= 37 vehicle 157 Medium Snow 3.00
	One hand	Music	Rain	00:35 - Following too close; lead time=4 speed= 7 vehicle 58 Medium Rain 3.00 02:18 - Maximum Speed Limit Exceeded 78 should be 75 5.00 03:23 - Following too close; lead time=4 speed= 43 vehicle 132 Medium Rain 3.00
	One hand	Silent	Rain	01:03 - Hard braking; Initial speed = 35.45 MPH 3.00 02:41 - High Speed Collision; Speed =53 5.00
	Two hands	News	Snow	00:29 - Following too close; lead time=4 speed= 19 vehicle 58 Medium Snow 3.00 00:42 - Hard braking; Initial speed = 31.78 MPH 3.00 01:08 - Following too close; lead time=2 speed= 34 vehicle 137 Medium Snow 3.00 01:30 - Hard braking; Initial speed = 56.29 MPH 3.00
	Two hands	Music	Snow	00:32 - Following too close; lead time=4 speed= 15 vehicle 58 Medium Snow 3.00 01:01 - Following too close; lead time=2 speed= 23 vehicle 137 Medium Snow 3.00 01:30 - Hard braking; Initial speed = 46.78 MPH 3.00 03:22 - Following too close; lead time=4 speed= 39 vehicle 132 Medium Snow 3.00
	One hand	Silent	Snow	02:09 - Following too close; lead time=4 speed= 34 vehicle 170 Medium Snow 3.00 03:40 - Hard braking; Initial speed = 29.22 MPH 3.00 03:49 - Following too close; lead time=4 speed= 30 vehicle 91 Medium Snow 3.00
	One hand	News	Rain	00:39 - Following too close; lead time=4 speed= 22 vehicle 156 Medium Rain 3.00
18-40 years, female, Participant 1	Two hands	Silent	Rain	No Violations 0.00
	One hand	Music	Snow	No Violations 0.00
	Two hands	News	Rain	01:45 - Following too close; lead time=3 speed= 18 vehicle 201 Medium Rain 3.00 02:02 - Following too close; lead time=3 speed= 17 vehicle 123 Medium Rain 3.00
	Two hands	Music	Rain	No Violations 0.00
	Two hands	Silent	Snow	01:12 - Following too close; lead time=4 speed= 15 vehicle 123 Medium Snow 3.00 02:33 - Following too close; lead time=4 speed= 19 vehicle 76 Medium Snow 3.00
	One hand	News	Snow	01:08 - Following too close; lead time=5 speed= 13 vehicle 179 Medium Snow 3.00 01:55 - Following too close; lead time=3 speed= 26 vehicle 30 Medium Snow 3.00
	One hand	Music	Rain	No Violations 0.00
	One hand	Silent	Rain	02:57 - Low Speed Collision; Speed =11 5.00
	Two hands	News	Snow	00:31 - Following too close; lead time=5 speed= 20 vehicle 15 Medium Snow 3.00
	Two hands	Music	Snow	01:13 - Following too close; lead time=4 speed= 24 vehicle 134 Medium Snow 3.00
	One hand	Silent	Snow	01:08 - Following too close; lead time=4 speed= 23 vehicle 193 Medium Snow 3.00

	One hand	News	Rain	No Violations 0.00
	Two hands	Silent	Rain	00:46 - Following too close; lead time=3 speed= 32 vehicle 123 Medium Rain 3.00 00:57 - Following too close; lead time=1 speed= 7 vehicle 137 Medium Rain 3.00 01:07 - Following too close; lead time=2 speed= 36 vehicle 137 Medium Rain 3.00
	One hand	Music	Snow	02:10 - Medium Speed Collision; Speed =24 5.00 03:53 - Medium Speed Collision; Other Vehicle Speed =25 5.00
	Two hands	News	Rain	00:42 - Following too close; lead time=1 speed= 26 vehicle 59 Medium Rain 3.00
	Two hands	Music	Rain	01:08 - Following too close; lead time=1 speed= 34 vehicle 137 3.00
	Two hands	Silent	Snow	No Violations 0.00
	One hand	News	Snow	00:32 - Following too close; lead time=4 speed= 24 vehicle 113 Medium Rain 3.00 00:54 - Following too close; lead time=3 speed= 6 vehicle 113 Medium Rain 3.00 01:10 - Following too close; lead time=3 speed= 23 vehicle 193 Medium Rain 3.00 02:15 - Following too close; lead time=3 speed= 29 vehicle 182 Medium Rain 3.00
18-40 years, female, Participant 2	One hand	Music	Rain	01:06 - Following too close; lead time=3 speed= 29 vehicle 123 Medium Rain 3.00 02:23 - Following too close; lead time=4 speed= 31 vehicle 12 Medium Rain 3.00 03:49 - Following too close; lead time=5 speed= 46 vehicle 141 Medium Rain 3.00
	One hand	Silent	Rain	01:08 - Following too close; lead time=1 speed= 34 vehicle 137 3.00
	Two hands	News	Snow	00:52 - Low Speed Collision; Speed =5 5.00 01:37 - Following too close; lead time=5 speed= 23 vehicle 71 Medium Snow 3.00 01:46 - Following too close; lead time=2 speed= 28 vehicle 71 Medium Snow 3.00 02:02 - Following too close; lead time=2 speed= 14 vehicle 174 Medium Snow 3.00
	Two hands	Music	Snow	01:50 - Following too close; lead time=4 speed= 25 vehicle 199 Medium Snow 3.00
	One hand	Silent	Snow	00:40 - Following too close; lead time=3 speed= 30 vehicle 123 Medium Rain 3.00 01:26 - Following too close; lead time=3 speed= 31 vehicle 166 Medium Rain 3.00 01:40 - Following too close; lead time=1 speed= 36 vehicle 140 Medium Rain 3.00
	One hand	News	Rain	01:12 - Following too close; lead time=2 speed= 12 vehicle 130 Medium Rain 3.00 01:49 - Low Speed Collision; Speed =15 5.00 03:37 - Following too close; lead time=4 speed= 40 vehicle 1 Medium Rain 3.00 03:40 - Hard braking; Initial speed = 35.29 MPH 3.00
18-40 years, female, Participant 3	Two hands	Silent	Rain	00:30 - Low Speed Collision; Speed =0 5.00 02:35 - Following too close; lead time=4 speed= 26 vehicle 130 Medium Rain 3.00 02:45 - Following too close; lead time=4 speed= 6 vehicle 130 Medium Rain 3.00 03:15 - Following too close; lead time=3 speed= 14 vehicle 4 Medium Rain 3.00 03:33 - Following too close; lead time=2 speed= 39 vehicle 4 Medium Rain 3.00

	One hand	Music	Snow		00:17 - Medium Speed Collision; Other Vehicle Speed =32 5.00 01:21 - Hard braking; Initial speed = 28.87 MPH 3.00 01:29 - Following too close; lead time=4 speed= 33 vehicle 54 Medium Snow 3.00 01:32 - Hard braking; Initial speed = 31.65 MPH 3.00 01:57 - Following too close; lead time=4 speed= 23 vehicle 91 Medium Snow 3.00 02:12 - Following too close; lead time=5 speed= 31 vehicle 91 Medium Snow 3.00 02:23 - Following too close; lead time=4 speed= 39 vehicle 91 Medium Snow 3.00 02:27 - Hard braking; Initial speed = 34.05 MPH 3.00 02:51 - Hard braking; Initial speed = 27.10 MPH 3.00 03:10 - Hard braking; Initial speed = 40.94 MPH 3.00 03:22 - Hard braking; Initial speed = 32.48 MPH 3.00 03:47 - Medium Speed Collision; Other Vehicle Speed =25 5.00
	Two hands	News	Rain		00:47 - Following too close; lead time=2 speed= 32 vehicle 123 Medium Rain 3.00
	Two hands	Music	Rain		01:03 - Following too close; lead time=2 speed= 30 vehicle 137 Medium Rain 3.00
	Two hands	Silent	Snow		00:52 - Following too close; lead time=3 speed= 20 vehicle 123 Medium Snow 3.00 01:08 - Following too close; lead time=2 speed= 32 vehicle 137 Medium Snow 3.00
	One hand	News	Snow		01:45 - Following too close; lead time=3 speed= 32 vehicle 1 Medium Snow 3.00 03:37 - Hard braking; Initial speed = 41.04 MPH 3.00
	One hand	Music	Rain		01:04 - Low Speed Collision; Speed =12 5.00 01:21 - Following too close; lead time=1 speed= 16 vehicle 35 Medium Rain 3.00 02:46 - Following too close; lead time=3 speed= 52 vehicle 142 Medium Rain 3.00
	One hand	Silent	Rain		01:17 - Following too close; lead time=1 speed= 24 vehicle 201 Medium Rain 3.00 02:04 - Following too close; lead time=4 speed= 43 vehicle 104 Medium Rain 3.00
	Two hands	News	Snow		01:07 - Following too close; lead time=1 speed= 36 vehicle 137 Medium Snow 3.00 01:28 - Hard braking; Initial speed = 56.50 MPH 3.00
	Two hands	Music	Snow		00:37 - Hard braking; Initial speed = 34.48 MPH 3.00 00:46 - Following too close; lead time=4 speed= 19 vehicle 123 Medium Snow 3.00 01:07 - Following too close; lead time=1 speed= 36 vehicle 137 Medium Snow 3.00 01:24 - Hard braking; Initial speed = 45.65 MPH 3.00 02:25 - Following too close; lead time=4 speed= 25 vehicle 128 Medium Snow 3.00 02:46 - Hard braking; Initial speed = 29.14 MPH 3.00
	One hand	Silent	Snow		01:27 - Following too close; lead time=5 speed= 20 vehicle 54 Medium Snow 3.00 02:12 - Following too close; lead time=4 speed= 38 vehicle 54 Medium Snow 3.00 02:20 - Hard braking; Initial speed = 32.41 MPH 3.00 03:21 - Hard braking; Initial speed = 57.40 MPH 3.00 03:34 - Hard braking; Initial speed = 45.61 MPH 3.00
	One hand	News	Rain		01:06 - Following too close; lead time=3 speed= 41 vehicle 137 Medium Rain 3.00
18-40 years, female, Participant 4	Two hands	Silent	Rain		No Violations 0.00
	One hand	Music	Snow	total damage	00:50 - Medium Speed Collision; Speed =23 5.00
	Two hands	News	Rain		00:42 - Hard braking; Initial speed = 38.80 MPH 3.00
	Two hands	Music	Rain		00:40 - Following too close; lead time=3 speed= 29 vehicle 59 Medium Rain 3.00 00:59 - Hard braking; Initial speed = 33.78 MPH 3.00 01:15 - Following too close; lead time=2 speed= 32 vehicle 200 Medium Rain 3.00

				02:22 - Following too close; lead time=1 speed= 31 vehicle 91 Medium Rain 3.00
	Two hands	Silent	Snow	00:47 - Following too close; lead time=4 speed= 30 vehicle 93 Medium Snow 3.00 02:43 - Hard braking; Initial speed = 32.46 MPH 3.00 03:39 - Hard braking; Initial speed = 35.83 MPH 3.00
	One hand	News	Snow	02:18 - Hard braking; Initial speed = 28.10 MPH 3.00 03:19 - Hard braking; Initial speed = 35.16 MPH 3.00
	One hand	Music	Rain	01:37 - Following too close; lead time=3 speed= 38 vehicle 123 Medium Rain 3.00 02:27 - Following too close; lead time=1 speed= 9 vehicle 203 Medium Rain 3.00
	One hand	Silent	Rain	00:47 - Following too close; lead time=3 speed= 27 vehicle 178 Medium Rain 3.00 01:01 - Following too close; lead time=2 speed= 32 vehicle 84 Medium Rain 3.00 01:41 - Following too close; lead time=3 speed= 10 vehicle 201 Medium Rain 3.00 02:01 - Low Speed Collision; Speed =13 5.00 02:48 - Following too close; lead time=2 speed= 44 vehicle 67 Medium Rain 3.00
	Two hands	News	Snow	00:52 - Medium Speed Collision; Other Vehicle Speed =35 5.00 01:03 - Following too close; lead time=1 speed= 34 vehicle 186 Medium Snow 3.00 01:28 - Hard braking; Initial speed = 31.44 MPH 3.00 01:55 - Following too close; lead time=6 speed= 51 vehicle 1 Medium Snow 3.00
	Two hands	Music	Snow	00:34 - Following too close; lead time=5 speed= 19 vehicle 72 Medium Snow 3.00 00:51 - Following too close; lead time=3 speed= 31 vehicle 203 Medium Snow 3.00 01:23 - Hard braking; Initial speed = 49.49 MPH 3.00 01:56 - Hard braking; Initial speed = 56.03 MPH 3.00 02:43 - Hard braking; Initial speed = 40.32 MPH 3.00 03:12 - Hard braking; Initial speed = 37.45 MPH 3.00 03:23 - Hard braking; Initial speed = 40.41 MPH 3.00
	One hand	Silent	Snow	00:34 - Following too close; lead time=2 speed= 22 vehicle 134 Medium Snow 3.00 01:12 - Hard braking; Initial speed = 26.37 MPH 3.00 01:31 - Hard braking; Initial speed = 36.13 MPH 3.00 02:08 - Following too close; lead time=5 speed= 29 vehicle 119 Medium Snow 3.00 03:51 - Hard braking; Initial speed = 25.88 MPH 3.00
	One hand	News	Rain	01:24 - Hard braking; Initial speed = 39.29 MPH 3.00
18-40 years, female, Participant 5	Two hands	Silent	Rain	02:23 - Following too close; lead time=3 speed= 7 vehicle 128 Medium Rain 3.00
	One hand	Music	Snow	01:10 - Hard braking; Initial speed = 27.82 MPH 3.00 02:05 - Hard braking; Initial speed = 31.27 MPH 3.00 02:31 - Following too close; lead time=6 speed= 43 vehicle 179 Medium Snow 3.00 02:34 - Hard braking; Initial speed = 39.11 MPH 3.00 04:00 - Following too close; lead time=5 speed= 49 vehicle 142 Medium Snow 3.00
	Two hands	News	Rain	01:16 - Following too close; lead time=0 speed= 28 vehicle 107 Medium Rain 3.00 02:46 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	Two hands	Music	Rain	00:54 - Following too close; lead time=3 speed= 23 vehicle 137 Medium Rain 3.00 01:21 - Following too close; lead time=4 speed= 39 vehicle 20 Medium Rain 3.00
	Two hands	Silent	Snow	01:27 - Following too close; lead time=4 speed= 31 vehicle 54 Medium Snow 3.00
	One hand	News	Snow	01:11 - Following too close; lead time=1 speed= 19 vehicle 43 Medium Snow 3.00

				01:24 - Following too close; lead time=3 speed= 26 vehicle 89 Medium Snow 3.00
	One hand	Music	Rain	00:41 - Following too close; lead time=3 speed= 7 vehicle 156 Medium Rain 3.00 01:30 - Following too close; lead time=4 speed= 32 vehicle 188 Medium Rain 3.00 02:14 - Hard braking; Initial speed = 41.89 MPH 3.00 02:22 - Following too close; lead time=2 speed= 22 vehicle 24 Medium Rain 3.00 02:53 - Following too close; lead time=2 speed= 12 vehicle 59 Medium Rain 3.00
	One hand	Silent	Rain	00:50 - Following too close; lead time=3 speed= 26 vehicle 105 Medium Rain 3.00
	Two hands	News	Snow	00:56 - Hard braking; Initial speed = 30.66 MPH 3.00
	Two hands	Music	Snow	00:39 - Following too close; lead time=4 speed= 14 vehicle 58 Medium Snow 3.00 01:45 - Following too close; lead time=3 speed= 21 vehicle 201 Medium Snow 3.00 02:06 - Following too close; lead time=4 speed= 30 vehicle 123 Medium Snow 3.00 02:10 - Hard braking; Initial speed = 26.81 MPH 3.00 03:18 - Hard braking; Initial speed = 34.91 MPH 3.00
	One hand	Silent	Snow	00:53 - Hard braking; Initial speed = 38.94 MPH 3.00 01:09 - Following too close; lead time=4 speed= 24 vehicle 123 Medium Snow 3.00 01:57 - Following too close; lead time=5 speed= 29 vehicle 166 Medium Snow 3.00 03:26 - Following too close; lead time=2 speed= 39 vehicle 34 Medium Snow 3.00 03:45 - Hard braking; Initial speed = 44.90 MPH 3.00
	One hand	News	Rain	01:24 - Following too close; lead time=3 speed= 34 vehicle 193 Medium Rain 3.00
41-90 years, male, Participant 1	Two hands	Silent	Rain	00:44 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	One hand	Music	Snow	01:37 - Following too close; lead time=4 speed= 26 vehicle 134 Medium Snow 3.00 01:53 - Following too close; lead time=4 speed= 34 vehicle 130 Medium Snow 3.00 02:19 - Following too close; lead time=6 speed= 35 vehicle 60 Medium Snow 3.00
	Two hands	News	Rain	No Violations 0.00
	Two hands	Music	Rain	03:34 - Following too close; lead time=4 speed= 18 vehicle 37 Medium Rain 3.00
	Two hands	Silent	Snow	01:19 - Following too close; lead time=1 speed= 18 vehicle 107 Medium Snow 3.00
	One hand	News	Snow	01:12 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	One hand	Music	Rain	02:21 - Following too close; lead time=2 speed= 16 vehicle 24 Medium Rain 3.00 02:49 - Following too close; lead time=2 speed= 10 vehicle 103 Medium Rain 3.00 03:16 - Following too close; lead time=1 speed= 19 vehicle 164 Medium Rain 3.00
	One hand	Silent	Rain	00:45 - Medium Speed Collision; Other Vehicle Speed =33 5.00
	Two hands	News	Snow	No Violations 0.00
	Two hands	Music	Snow	03:12 - Following too close; lead time=4 speed= 15 vehicle 91 Medium Snow 3.00
	One hand	Silent	Snow	No Violations 0.00
	One hand	News	Rain	No Violations 0.00
	Two hands	Silent	Rain	04:01 - Low Speed Collision; Speed =9 5.00

41-90 years, male, Participant 2	One hand	Music	Snow		01:24 - Following too close; lead time=3 speed= 26 vehicle 123 Medium Snow 3.00 02:37 - Hard braking; Initial speed = 41.41 MPH 3.00 03:10 - Following too close; lead time=4 speed= 28 vehicle 152 Medium Snow 3.00
	Two hands	News	Rain		No Violations 0.00
	Two hands	Music	Rain		01:25 - Medium Speed Collision; Other Vehicle Speed =24 5.00
	Two hands	Silent	Snow		No Violations 0.00
	One hand	News	Snow		01:49 - Following too close; lead time=4 speed= 17 vehicle 123 Medium Snow 3.00 02:28 - Following too close; lead time=2 speed= 10 vehicle 39 Medium Snow 3.00 02:40 - Following too close; lead time=4 speed= 17 vehicle 108 Medium Snow 3.00
	One hand	Music	Rain		00:44 - Following too close; lead time=2 speed= 14 vehicle 58 Medium Rain 3.00 01:12 - Following too close; lead time=3 speed= 22 vehicle 123 Medium Rain 3.00 01:30 - Hard braking; Initial speed = 42.25 MPH 3.00 02:13 - Following too close; lead time=3 speed= 13 vehicle 166 Medium Rain 3.00
	One hand	Silent	Rain		00:49 - Following too close; lead time=3 speed= 28 vehicle 123 Medium Rain 3.00 01:30 - Hard braking; Initial speed = 58.79 MPH 3.00 02:05 - Hard braking; Initial speed = 63.93 MPH 3.00 02:55 - Hard braking; Initial speed = 58.78 MPH 3.00 03:27 - Hard braking; Initial speed = 53.54 MPH 3.00 03:54 - Hard braking; Initial speed = 54.58 MPH 3.00
	Two hands	News	Snow		00:42 - Hard braking; Initial speed = 36.51 MPH 3.00 01:02 - Following too close; lead time=2 speed= 23 vehicle 123 Medium Snow 3.00 01:18 - Hard braking; Initial speed = 45.41 MPH 3.00 01:30 - Following too close; lead time=3 speed= 25 vehicle 203 Medium Snow 3.00 03:26 - Hard braking; Initial speed = 37.49 MPH 3.00 03:37 - Hard braking; Initial speed = 40.50 MPH 3.00 03:46 - Hard braking; Initial speed = 44.27 MPH 3.00
	Two hands	Music	Snow		04:21 - Hard braking; Initial speed = 42.57 MPH 3.00
	One hand	Silent	Snow		01:20 - Following too close; lead time=3 speed= 27 vehicle 123 Medium Snow 3.00 01:37 - Hard braking; Initial speed = 36.79 MPH 3.00 01:59 - Hard braking; Initial speed = 33.79 MPH 3.00 02:34 - Following too close; lead time=1 speed= 30 vehicle 47 Medium Snow 3.00 02:49 - Hard braking; Initial speed = 55.62 MPH 3.00 03:09 - Following too close; lead time=2 speed= 35 vehicle 175 Medium Snow 3.00 03:26 - Too fast for Medium Snow conditions: 71 should be 65 5.00 03:28 - Hard braking; Initial speed = 70.30 MPH 3.00
	One hand	News	Rain		00:58 - Following too close; lead time=2 speed= 8 vehicle 137 Medium Rain 3.00 01:08 - Following too close; lead time=2 speed= 37 vehicle 137 Medium Rain 3.00
41-90 years, male, Participant 3	Two hands	Silent	Rain		01:28 - Hard braking; Initial speed = 39.69 MPH 3.00 02:15 - Following too close; lead time=5 speed= 64 vehicle 14 Medium Rain 3.00
	One hand	Music	Snow	total damage	00:53 - Cab collided with a structure (100832) Speed=24 Weight= 5.0 5.00

	Two hands	News	Rain	00:47 - Following too close; lead time=3 speed= 30 vehicle 93 Medium Rain 3.00 01:14 - Following too close; lead time=4 speed= 32 vehicle 192 Medium Rain 3.00 01:50 - Hard braking; Initial speed = 68.58 MPH 3.00 02:04 - Hard braking; Initial speed = 52.35 MPH 3.00 02:35 - Maximum Speed Limit Exceeded 81 should be 75 5.00 02:43 - Hard braking; Initial speed = 82.76 MPH 3.00 03:00 - Hard braking; Initial speed = 56.31 MPH 3.00
	Two hands	Music	Rain	00:55 - Following too close; lead time=4 speed= 39 vehicle 35 Medium Rain 3.0001:04 - Following too close; lead time=3 speed= 15 vehicle 35 Medium Rain 3.0001:26 - Hard braking; Initial speed = 38.00 MPH 3.0001:37 - Following too close; lead time=3 speed= 42 vehicle 89 Medium Rain 3.0001:49 - Following too close; lead time=3 speed= 42 vehicle 43 Medium Rain 3.0002:01 - Following too close; lead time=4 speed= 40 vehicle 43 Medium Rain 3.0002:17 - Following too close; lead time=3 speed= 26 vehicle 43 Medium Rain 3.0002:50 - Following too close; lead time=3 speed= 37 vehicle 178 Medium Rain 3.0003:02 - Hard braking; Initial speed = 38.25 MPH 3.0003:18 - Hard braking; Initial speed = 52.78 MPH 3.0003:38 - Hard braking; Initial speed = 44.10 MPH 3.00
	Two hands	Silent	Snow	00:42 - Hard braking; Initial speed = 27.73 MPH 3.00 00:57 - Following too close; lead time=3 speed= 16 vehicle 137 Medium Snow 3.00 01:08 - Following too close; lead time=4 speed= 33 vehicle 137 Medium Snow 3.00 01:25 - Hard braking; Initial speed = 45.11 MPH 3.00
	One hand	News	Snow	00:49 - Following too close; lead time=4 speed= 22 vehicle 93 Medium Snow 3.00 01:09 - Following too close; lead time=4 speed= 18 vehicle 195 Medium Snow 3.00 02:23 - Hard braking; Initial speed = 46.32 MPH 3.00 03:46 - Hard braking; Initial speed = 56.71 MPH 3.00
	One hand	Music	Rain	01:16 - Following too close; lead time=3 speed= 29 vehicle 186 Medium Rain 3.00 01:56 - Hard braking; Initial speed = 39.18 MPH 3.00 03:20 - Hard braking; Initial speed = 56.81 MPH 3.00
	One hand	Silent	Rain	00:42 - Hard braking; Initial speed = 42.46 MPH 3.00 01:08 - Following too close; lead time=3 speed= 37 vehicle 137 Medium Rain 3.00 01:32 - Hard braking; Initial speed = 49.34 MPH 3.00
	Two hands	News	Snow	00:37 - Following too close; lead time=5 speed= 11 vehicle 58 Medium Snow 3.00 01:13 - Following too close; lead time=4 speed= 22 vehicle 123 Medium Snow 3.00 03:42 - Following too close; lead time=4 speed= 33 vehicle 132 Medium Snow 3.00
	Two hands	Music	Snow	00:35 - Hard braking; Initial speed = 39.25 MPH 3.00 00:42 - Following too close; lead time=3 speed= 28 vehicle 123 Medium Snow 3.00 01:07 - Following too close; lead time=1 speed= 35 vehicle 137 Medium Snow 3.00 01:26 - Hard braking; Initial speed = 42.18 MPH 3.00
	One hand	Silent	Snow	03:08 - Hard braking; Initial speed = 26.75 MPH 3.00 03:20 - Hard braking; Initial speed = 35.62 MPH 3.00 03:56 - Hard braking; Initial speed = 26.71 MPH 3.00
	One hand	News	Rain	01:22 - Following too close; lead time=2 speed= 42 vehicle 109 Medium Rain 3.00 01:40 - Following too close; lead time=2 speed= 35 vehicle 50 Medium Rain 3.00 02:04 - Following too close; lead time=4 speed= 15 vehicle 203 Medium Rain 3.00 02:20 - Following too close; lead time=4 speed= 40 vehicle 166 Medium Rain 3.00
41-90 years, male, Participant 4	Two hands	Silent	Rain	02:38 - Following too close; lead time=3 speed= 38 vehicle 66 Medium Rain 3.00 02:59 - Hard braking; Initial speed = 38.65 MPH 3.00 03:44 - Hard braking; Initial speed = 43.65 MPH 3.00

				03:49 - Following too close; lead time=3 speed= 35 vehicle 134 Medium Rain 3.00
	One hand	Music	Snow	00:40 - Hard braking; Initial speed = 39.56 MPH 3.00 01:45 - Hard braking; Initial speed = 41.33 MPH 3.00 02:25 - Hard braking; Initial speed = 47.84 MPH 3.00 02:50 - Following too close; lead time=5 speed= 34 vehicle 37 Medium Snow 3.00
	Two hands	News	Rain	00:31 - Following too close; lead time=2 speed= 35 vehicle 134 Medium Rain 3.00 00:51 - Following too close; lead time=3 speed= 26 vehicle 195 Medium Rain 3.00 01:02 - Medium Speed Collision; Other Vehicle Speed =26 5.00
	Two hands	Music	Rain	00:33 - Hard braking; Initial speed = 40.22 MPH 3.00 00:43 - Hard braking; Initial speed = 39.95 MPH 3.00 00:52 - Following too close; lead time=5 speed= 44 vehicle 51 Medium Rain 3.00 01:02 - Following too close; lead time=3 speed= 31 vehicle 156 Medium Rain 3.00 01:17 - Following too close; lead time=2 speed= 39 vehicle 35 Medium Rain 3.00 01:32 - Following too close; lead time=2 speed= 53 vehicle 35 Medium Rain 3.00 02:28 - Following too close; lead time=4 speed= 54 vehicle 142 Medium Rain 3.00 02:38 - Following too close; lead time=3 speed= 55 vehicle 142 Medium Rain 3.00 02:48 - Following too close; lead time=2 speed= 27 vehicle 157 Medium Rain 3.00 03:49 - Following too close; lead time=4 speed= 43 vehicle 11 Medium Rain 3.00
	Two hands	Silent	Snow	00:37 - Hard braking; Initial speed = 33.53 MPH 3.00 01:28 - Hard braking; Initial speed = 59.97 MPH 3.00 03:20 - Following too close; lead time=4 speed= 44 vehicle 132 Medium Snow 3.00
	One hand	News	Snow	00:48 - Hard braking; Initial speed = 25.65 MPH 3.00 02:38 - Hard braking; Initial speed = 31.54 MPH 3.00
	One hand	Music	Rain	00:31 - Following too close; lead time=3 speed= 36 vehicle 16 Medium Rain 3.0000:44 - Following too close; lead time=2 speed= 42 vehicle 16 Medium Rain 3.0001:14 - Following too close; lead time=3 speed= 31 vehicle 170 Medium Rain 3.0001:39 - Following too close; lead time=3 speed= 39 vehicle 1 Medium Rain 3.0002:04 - Following too close; lead time=4 speed= 48 vehicle 94 Medium Rain 3.00
	One hand	Silent	Rain	00:32 - Hard braking; Initial speed = 45.14 MPH 3.00 00:42 - Hard braking; Initial speed = 39.85 MPH 3.00 00:49 - Following too close; lead time=2 speed= 34 vehicle 194 Medium Rain 3.00 01:03 - Following too close; lead time=2 speed= 17 vehicle 194 Medium Rain 3.00 02:16 - Hard braking; Initial speed = 47.98 MPH 3.00
	Two hands	News	Snow	01:01 - Following too close; lead time=4 speed= 24 vehicle 196 Medium Snow 3.00 01:40 - Following too close; lead time=4 speed= 33 vehicle 31 Medium Snow 3.00 02:07 - Medium Speed Collision; Other Vehicle Speed =26 5.00 02:13 - Following too close; lead time=3 speed= 23 vehicle 27 Medium Snow 3.00 02:33 - Following too close; lead time=3 speed= 7 vehicle 27 Medium Snow 3.00 02:45 - Following too close; lead time=2 speed= 7 vehicle 27 Medium Snow 3.00 03:04 - Following too close; lead time=4 speed= 18 vehicle 157 Medium Snow 3.00 03:38 - Following too close; lead time=3 speed= 37 vehicle 157 Medium Snow 3.00

				03:52 - Following too close; lead time=6 speed= 42 vehicle 174 Medium Snow 3.00
	Two hands	Music	Snow	00:35 - Hard braking; Initial speed = 42.44 MPH 3.00 01:22 - Hard braking; Initial speed = 52.98 MPH 3.00 01:39 - Hard braking; Initial speed = 27.72 MPH 3.00 02:08 - Following too close; lead time=5 speed= 26 vehicle 56 Medium Snow 3.00 03:09 - Hard braking; Initial speed = 43.29 MPH 3.00 03:26 - Hard braking; Initial speed = 32.80 MPH 3.00 03:41 - Hard braking; Initial speed = 40.60 MPH 3.00
	One hand	Silent	Snow	00:29 - Following too close; lead time=4 speed= 21 vehicle 113 Medium Snow 3.00 00:39 - Following too close; lead time=3 speed= 6 vehicle 113 Medium Snow 3.00 02:20 - Hard braking; Initial speed = 57.36 MPH 3.00 03:46 - Hard braking; Initial speed = 43.69 MPH 3.00
	One hand	News	Rain	00:36 - Hard braking; Initial speed = 36.33 MPH 3.00 02:07 - Following too close; lead time=3 speed= 38 vehicle 181 Medium Rain 3.00 03:41 - Following too close; lead time=3 speed= 25 vehicle 64 Medium Rain 3.00
41-90 years, male, Participant 5	Two hands	Silent	Rain	No Violations 0.00
	One hand	Music	Snow	00:42 - Following too close; lead time=4 speed= 7 vehicle 58 Medium Snow 3.00
	Two hands	News	Rain	No Violations 0.00
	Two hands	Music	Rain	02:36 - Following too close; lead time=4 speed= 43 vehicle 94 Medium Rain 3.00 03:41 - Following too close; lead time=3 speed= 38 vehicle 53 Medium Rain 3.00
	Two hands	Silent	Snow	00:45 - Following too close; lead time=4 speed= 26 vehicle 190 Medium Snow 3.00 01:27 - Following too close; lead time=1 speed= 17 vehicle 59 Medium Snow 3.00
	One hand	News	Snow	00:39 - Medium Speed Collision; Other Vehicle Speed =20 5.00 02:01 - Following too close; lead time=5 speed= 29 vehicle 41 Medium Snow 3.00 02:20 - Hard braking; Initial speed = 27.96 MPH 3.00 03:23 - Following too close; lead time=5 speed= 21 vehicle 141 Medium Snow 3.00
	One hand	Music	Rain	No Violations 0.00
	One hand	Silent	Rain	03:12 - Following too close; lead time=3 speed= 26 vehicle 170 Medium Rain 3.00
	Two hands	News	Snow	00:36 - Hard braking; Initial speed = 33.86 MPH 3.00
	Two hands	Music	Snow	02:34 - Following too close; lead time=4 speed= 17 vehicle 35 Medium Snow 3.00 03:40 - Following too close; lead time=4 speed= 39 vehicle 142 Medium Snow 3.00
	One hand	Silent	Snow	01:28 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	One hand	News	Rain	01:04 - Low Speed Collision; Speed =10 5.00
41-90 years, female, Participant 1	Two hands	Silent	Rain	No Violations 0.00
	One hand	Music	Snow	No Violations 0.00

	Two hands	News	Rain		No Violations 0.00
	Two hands	Music	Rain		No Violations 0.00
	Two hands	Silent	Snow		No Violations 0.00
	One hand	News	Snow		No Violations 0.00
	One hand	Music	Rain		No Violations 0.00
	One hand	Silent	Rain		No Violations 0.00
	Two hands	News	Snow		01:13 - Following too close; lead time=3 speed= 26 vehicle 123 Medium Snow 3.00 02:27 - Following too close; lead time=5 speed= 15 vehicle 76 Medium Snow 3.00
	Two hands	Music	Snow		02:50 - Following too close; lead time=4 speed= 8 vehicle 130 Medium Snow 3.00
	One hand	Silent	Snow		No Violations 0.00
	One hand	News	Rain		02:13 - Following too close; lead time=2 speed= 11 vehicle 39 Medium Rain 3.00
41-90 years, female, Participant 2	Two hands	Silent	Rain		00:34 - Following too close; lead time=3 speed= 16 vehicle 58 Medium Rain 3.00 01:24 - Following too close; lead time=3 speed= 25 vehicle 123 Medium Rain 3.00
	One hand	Music	Snow		01:17 - Hard braking; Initial speed = 28.04 MPH 3.0002:52 - Following too close; lead time=5 speed= 30 vehicle 175 Medium Snow 3.0003:12 - Hard braking; Initial speed = 42.55 MPH 3.00
	Two hands	News	Rain		No Violations 0.00
	Two hands	Music	Rain		01:24 - Following too close; lead time=3 speed= 22 vehicle 123 Medium Rain 3.00 03:19 - Following too close; lead time=3 speed= 24 vehicle 128 Medium Rain 3.00
	Two hands	Silent	Snow		00:53 - Following too close; lead time=3 speed= 15 vehicle 137 Medium Snow 3.00 01:21 - Following too close; lead time=5 speed= 42 vehicle 20 Medium Snow 3.00
	One hand	News	Snow		01:21 - Following too close; lead time=5 speed= 25 vehicle 54 Medium Snow 3.00 02:58 - Following too close; lead time=3 speed= 20 vehicle 112 Medium Snow 3.00
	One hand	Music	Rain		00:34 - Following too close; lead time=4 speed= 12 vehicle 58 Medium Rain 3.00 02:23 - Following too close; lead time=1 speed= 20 vehicle 49 Medium Rain 3.00 02:43 - Following too close; lead time=1 speed= 21 vehicle 91 Medium Rain 3.00
	One hand	Silent	Rain		01:26 - Following too close; lead time=3 speed= 26 vehicle 189 Medium Rain 3.00 02:14 - Following too close; lead time=3 speed= 21 vehicle 24 Medium Rain 3.00 03:08 - Following too close; lead time=1 speed= 17 vehicle 164 Medium Rain 3.00
	Two hands	News	Snow	total damage	00:35 - Following too close; lead time=4 speed= 24 vehicle 113 Medium Snow 3.00 01:00 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	Two hands	Music	Snow		01:06 - Medium Speed Collision; Other Vehicle Speed =20 5.00 01:22 - Following too close; lead time=4 speed= 17 vehicle 44 Medium Snow 3.00 01:27 - Low Speed Collision; Speed =15 5.00 02:48 - Following too close; lead time=4 speed= 19 vehicle 24 Medium Snow 3.00 03:04 - Following too close; lead time=4 speed= 21 vehicle 123 Medium Snow 3.00

	One hand	Silent	Snow		01:02 - Low Speed Collision; Speed =11 5.00 02:28 - Following too close; lead time=2 speed= 11 vehicle 93 Medium Snow 3.00
	One hand	News	Rain		01:32 - Following too close; lead time=2 speed= 12 vehicle 107 Medium Rain 3.00
41-90 years, female, Participant 3	Two hands	Silent	Rain		01:38 - Following too close; lead time=5 speed= 20 vehicle 60 Medium Rain 3.00
	One hand	Music	Snow		No Violations 0.00
	Two hands	News	Rain	total damage	03:03 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	Two hands	Music	Rain		No Violations 0.00
	Two hands	Silent	Snow		01:24 - Following too close; lead time=4 speed= 17 vehicle 127 Medium Snow 3.00 02:03 - Following too close; lead time=4 speed= 19 vehicle 200 Medium Snow 3.00
	One hand	News	Snow		01:02 - Medium Speed Collision; Other Vehicle Speed =35 5.00 02:50 - Following too close; lead time=4 speed= 14 vehicle 35 Medium Snow 3.00 03:13 - Following too close; lead time=5 speed= 28 vehicle 35 Medium Snow 3.00
	One hand	Music	Rain		00:37 - Following too close; lead time=4 speed= 12 vehicle 58 Medium Rain 3.00 02:34 - Cab collided with a structure (101052) Speed=6 Weight= 5.0 5.00 02:58 - Low Speed Collision; Speed =19 5.00
	One hand	Silent	Rain		No Violations 0.00
	Two hands	News	Snow		No Violations 0.00
	Two hands	Music	Snow		No Violations 0.00
	One hand	Silent	Snow		00:35 - Following too close; lead time=4 speed= 22 vehicle 134 Medium Snow 3.00 00:52 - Following too close; lead time=4 speed= 23 vehicle 196 Medium Snow 3.00 03:56 - Medium Speed Collision; Other Vehicle Speed =21 5.00
	One hand	News	Rain		01:14 - Following too close; lead time=4 speed= 16 vehicle 15 Medium Rain 3.00 01:56 - Following too close; lead time=4 speed= 22 vehicle 30 Medium Rain 3.00
41-90 years, female, Participant 4	Two hands	Silent	Rain		01:31 - Following too close; lead time=3 speed= 11 vehicle 156 Medium Rain 3.00 02:33 - Following too close; lead time=3 speed= 23 vehicle 170 Medium Rain 3.00 02:43 - Medium Speed Collision; Other Vehicle Speed =35 5.00 03:45 - Medium Speed Collision; Other Vehicle Speed =35 5.00
	One hand	Music	Snow		01:23 - Following too close; lead time=3 speed= 39 vehicle 127 Medium Snow 3.00 01:26 - Hard braking; Initial speed = 39.89 MPH 3.00 02:00 - Hard braking; Initial speed = 35.72 MPH 3.00 02:58 - Hard braking; Initial speed = 32.01 MPH 3.00
	Two hands	News	Rain		01:31 - Following too close; lead time=2 speed= 39 vehicle 93 Medium Rain 3.00 02:19 - Following too close; lead time=5 speed= 42 vehicle 130 Medium Rain 3.00 03:50 - Following too close; lead time=4 speed= 25 vehicle 134 Medium Rain 3.00
	Two hands	Music	Rain		00:31 - Following too close; lead time=4 speed= 20 vehicle 113 Medium Rain 3.00 00:52 - Following too close; lead time=3 speed= 5 vehicle 113 Medium Rain 3.00 01:10 - Following too close; lead time=3 speed= 28 vehicle 192 Medium Rain 3.00 01:50 - Following too close; lead time=3 speed= 31 vehicle 143 Medium Rain 3.00 02:31 - Following too close; lead time=3 speed= 27 vehicle 181

					Medium Rain 3.00 03:21 - Following too close; lead time=3 speed= 24 vehicle 128 Medium Rain 3.00
	Two hands	Silent	Snow		00:44 - Hard braking; Initial speed = 28.90 MPH 3.0001:22 - Hard braking; Initial speed = 34.88 MPH 3.0002:51 - Following too close; lead time=4 speed= 32 vehicle 41 Medium Snow 3.0003:47 - Hard braking; Initial speed = 29.92 MPH 3.00
	One hand	News	Snow		00:31 - Following too close; lead time=3 speed= 17 vehicle 58 Medium Snow 3.00 02:10 - Following too close; lead time=1 speed= 14 vehicle 39 Medium Snow 3.00
	One hand	Music	Rain		01:18 - Following too close; lead time=2 speed= 38 vehicle 35 Medium Rain 3.00
	One hand	Silent	Rain		00:29 - Following too close; lead time=3 speed= 29 vehicle 134 Medium Rain 3.00 01:52 - Following too close; lead time=3 speed= 38 vehicle 71 Medium Rain 3.00 02:04 - Following too close; lead time=2 speed= 12 vehicle 71 Medium Rain 3.00 02:37 - Following too close; lead time=2 speed= 8 vehicle 71 Medium Rain 3.00
	Two hands	News	Snow		No Violations 0.00
	Two hands	Music	Snow		00:45 - Hard braking; Initial speed = 31.93 MPH 3.00 00:52 - Medium Speed Collision; Other Vehicle Speed =35 5.00 01:00 - Following too close; lead time=3 speed= 20 vehicle 137 Medium Snow 3.00 03:52 - Hard braking; Initial speed = 30.73 MPH 3.00
	One hand	Silent	Snow		00:37 - Following too close; lead time=4 speed= 32 vehicle 156 Medium Snow 3.00 01:11 - Following too close; lead time=5 speed= 16 vehicle 156 Medium Snow 3.00 01:41 - Following too close; lead time=6 speed= 24 vehicle 179 Medium Snow 3.00
	One hand	News	Rain		01:08 - Following too close; lead time=2 speed= 30 vehicle 137 3.00 03:41 - Following too close; lead time=2 speed= 43 vehicle 61 3.00
41-90 years, female, Participant 5	Two hands	Silent	Rain		02:25 - Following too close; lead time=3 speed= 38 vehicle 35 Medium Rain 3.00 03:10 - Following too close; lead time=3 speed= 45 vehicle 35 Medium Rain 3.00
	One hand	Music	Snow	total damage	01:32 - Medium Speed Collision; Speed =26 5.00
	Two hands	News	Rain		01:05 - Hard braking; Initial speed = 41.33 MPH 3.00 01:16 - Following too close; lead time=3 speed= 35 vehicle 134 Medium Rain 3.00 01:36 - Following too close; lead time=1 speed= 35 vehicle 179 Medium Rain 3.00 02:08 - Following too close; lead time=4 speed= 45 vehicle 196 Medium Rain 3.00 02:23 - Hard braking; Initial speed = 37.42 MPH 3.00 02:35 - Hard braking; Initial speed = 35.81 MPH 3.00 02:41 - Following too close; lead time=1 speed= 37 vehicle 24 Medium Rain 3.00 02:55 - Hard braking; Initial speed = 41.11 MPH 3.00 03:28 - Following too close; lead time=3 speed= 47 vehicle 128 Medium Rain 3.00
	Two hands	Music	Rain		01:04 - Following too close; lead time=3 speed= 41 vehicle 195 Medium Rain 3.00 01:20 - Hard braking; Initial speed = 40.83 MPH 3.00 02:05 - Following too close; lead time=3 speed= 38 vehicle 201 Medium Rain 3.00 02:43 - Following too close; lead time=3 speed= 22 vehicle 180 Medium Rain 3.00

	Two hands	Silent	Snow	00:34 - Medium Speed Collision; Other Vehicle Speed =27 5.00 01:12 - Hard braking; Initial speed = 32.23 MPH 3.00 01:24 - Hard braking; Initial speed = 37.74 MPH 3.00
	One hand	News	Snow	00:32 - Hard braking; Initial speed = 33.56 MPH 3.00 01:19 - Following too close; lead time=1 speed= 25 vehicle 35 Medium Snow 3.00 02:15 - Hard braking; Initial speed = 39.28 MPH 3.00 02:39 - Hard braking; Initial speed = 47.59 MPH 3.00 03:00 - Hard braking; Initial speed = 43.49 MPH 3.00 03:20 - Hard braking; Initial speed = 38.73 MPH 3.00
	One hand	Music	Rain	01:07 - Hard braking; Initial speed = 40.07 MPH 3.00 02:18 - Following too close; lead time=4 speed= 41 vehicle 113 Medium Rain 3.00
	One hand	Silent	Rain	01:48 - Hard braking; Initial speed = 41.42 MPH 3.00
	Two hands	News	Snow	No Violations 0.00
	Two hands	Music	Snow	00:49 - Hard braking; Initial speed = 37.18 MPH 3.00 01:33 - Hard braking; Initial speed = 26.73 MPH 3.00 02:42 - Hard braking; Initial speed = 27.65 MPH 3.00 02:50 - Following too close; lead time=4 speed= 29 vehicle 91 Medium Snow 3.00
	One hand	Silent	Snow	00:47 - Hard braking; Initial speed = 28.98 MPH 3.00 01:32 - Following too close; lead time=5 speed= 8 vehicle 130 Medium Snow 3.00 02:03 - Following too close; lead time=4 speed= 28 vehicle 93 Medium Snow 3.00 02:35 - Following too close; lead time=4 speed= 27 vehicle 49 Medium Snow 3.00 02:44 - Following too close; lead time=4 speed= 26 vehicle 20 Medium Snow 3.00 03:07 - Following too close; lead time=5 speed= 37 vehicle 102 Medium Snow 3.00
	One hand	News	Rain	03:28 - Following too close; lead time=4 speed= 46 vehicle 142 Medium Rain 3.00

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